VOL. 5 NO. 2
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Energy Research Abstracts

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UNITED STATES DEPARTMENT OF ENERGY

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ENERGY RESEARCH ABSTRACTS

Volume 5, Number 2, January 31, 1980

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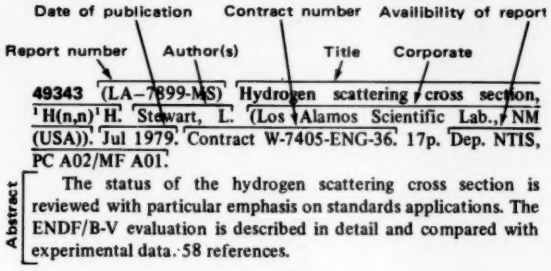
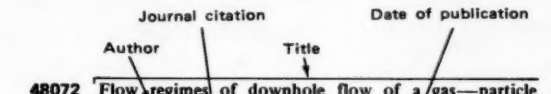


49343 (LA–7899-MS) Hydrogen scattering cross section, $^{1}H(n,n)^{1}H$. Stewart, L. (Los Alamos Scientific Lab., NM (USA)). Jul 1979. Contract W-7405-ENG-36. 17p. Dep. NTIS, PC A02/MF A01.

Abstract: The status of the hydrogen scattering cross section is reviewed with particular emphasis on standards applications. The ENDF/B-V evaluation is described in detail and compared with experimental data. 58 references.



48072 Flow regimes of downhole flow of a gas—particle mixture. Stokes, V.K. (Foster-Miller Associates, Inc., Waltham, MA). *J. Fluids Eng.*; 100: No. 4, 410-413 (Dec 1978).

Abstract: Assuming that a gas—particle mixture behaves like a homogeneous gas, in which the slip velocity of the particles is negligible, the various flow regimes in one-dimensional downhole flow, including the effects of gravity, compressiblity and wall friction, have been investigated. It is assumed that the flow is isothermal and that the wall shear can be accounted for by an empirically determined friction factor.

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49343 (LA–7899-MS) Hydrogen scattering cross section, $^{1}H(n,n)^{1}H$. Stewart, L. **(Los Alamos Scientific Lab., NM (USA))**. Jul 1979. Contract W-7405-ENG-36. 17p. Dep. NTIS, PC A02/MF A01.

is indexed as:

Los Alamos Scientific Lab., NM (USA)
Advanced laser fusion target fabrication research and development proposal, 4:48249 (LA–7619-P)
Hydrogen scattering cross section, $^{1}H(n,n)^{1}H$, 4:49343 (LA–7899-MS)
Low temperature physics and engineering. Quarterly progress report, January 1–March 31, 1979, 4:48988 (LA–7848-PR)

Author Index

Each author's name is indexed in the form appearing on the document abstracted, with the exception that given names are reduced to initials:

Stewart, L., Hydrogen scattering cross section, $^{1}H(n,n)^{1}H$, 4:49343 (LA–7899-MS)
Stewart, M.D., *See* McInroy, J.F., 4:49280
Stewart, W., *See* Dean, J.W., 4:48543
Stimson, J., Reproduction, growth, and survival of Eniwetak corals, 4:49200 (NVO–0703-1, pp 56-59)

Subject Index

The subject index consisting of entries naming specific materials, objects, and processes is arranged alphabetically. Document titles, informative phrases, or both specific to these entries are arranged alphabetically under the entries.

Examples:

HYDROGEN 1 TARGET/NEUTRON REACTIONS
Hydrogen scattering cross section, $^{1}H(n,n)^{1}H$ (Above 100 keV, review), 4:49343 (LA–7899-MS)
HYDROGEN NITRATES
See NITRIC ACID
HYDROLOGY/RESEARCH PROGRAMS
Inventory of advanced energy technologies and energy conservation research and development: 1976-1978. Volume II. Prepared for the Committee on Science and Technology, U.S. House of Representatives, Ninety-Sixth Congress, 4:48749

Contract Number Index

DOE technical report literature is indexed using contract numbers. This index contains the contract number with corresponding abstract and report numbers.

W-7405-ENG-36	**Gesellschaft fuer Kernforschung m.b.H., Karlsruhe (Germany, F.R.)**	
	3:49698	LA-tr–78-45
	3:49857	LA–7224T
	3:49863	LA–7235-MS
W-7405-ENG-48	**California Univ., Livermore (USA). Lawrence Livermore Lab.**	
	3:49386	UCRL–52456
	3:49431	UCRL–52405

Report Number Index

Technical report literature is also indexed using report numbers. This index includes information on where individual reports may be obtained. While not reports, patents and conference papers are indexed here as a matter of convenience.

LA-		
7899-MS	**4:49343**	**Dep. NTIS, PC A02/MF A01**
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ENERGY RESEARCH ABSTRACTS

COAL AND COAL PRODUCTS

2374 (NP—24146) **Steinkohlenbergbauverein annual report 1977.** (Steinkohlenbergbauverein, Essen (Germany, F.R.)). 1977. 143p. (In German). Dep. NTIS (US Sales Only), PC A07/MF A01.

Three chapters from the German coal industry 1977 annual report have been entered individually into EDB. (LTN)

PROCESSING

REFER ALSO TO CITATION(S) 2483

CARBONIZATION

REFER ALSO TO CITATION(S) 2453

DESULFURIZATION AND PURIFICATION

REFER ALSO TO CITATION(S) 2386, 2408, 2415, 2454, 2455

2375 (DOE/EV—0046(Vol.1), pp 28-31) **Coal preparation: an effective means of controlling coal wastes.** Warnke, W.E. (Dept. of Energy, Washington, DC). Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

Sulfur dioxide emissions from stack gases can be simply but effectively controlled by pre-combustion cleanup of coal. Many of the trace elements commonly associated with coal can also be controlled through precombustion cleanup. In order to reduce sulfur to acceptable levels, complex physical and chemical processes are required in contrast to simple process used to remove the coarse ash minerals. When the ash minerals and pyrite are almost totally removed by the newer processes involving fine grinding and multiphase separation procedures, elements such as arsenic, lead, zinc, cadmium and others are also removed. Waste products containing the sulfur and trace elements can be safely stored as land fill. The presentation summarizes projects and programs presently underway to control pollution from using coal.

2376 (DOE/EV—0046(Vol.1), pp 73-94) **Implications of analysis of high gradient magnetic separation to coal related applications.** Treat, R. (Dept. of Energy, Morgantown, WV); Simons, W.H. Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

The results of a recent METC report describing the ranges of physical parameters and conditions (flow velocity, magnetic field strength, and particle properties) considered favorable for wet and dry high gradient magnetic separation (HGMS) and some potential uses of this technique in coal energy related cleanup tasks is presented. These results are based upon theoretical single fiber modeling of HGMS performed at METC. An overview of the basic research and the implications of these studies on the applicability of single and multiple fiber models of fibrous filters is discussed. The cross section for particle collisions with an isolated magnetized fiber in air and water is given as a function of the physical parameters of the filter system. Two models for using the cross section to predict real filter efficiency are discussed. The analysis of particles in air shows a strong dependence of cross section on particle inertia and gravity and pronounced maxima in the cross section at small particle radii, features which are not present in liquids. The cross section in air is especially sensitive to particle size at small particle radii and to the free stream velocity. The cross section in air is reasonably large for a range of conditions, which supports the view that economically practical applications of magnetic filters in air-particle separations may be possible.

2377 (FE—2028-13) **Kinetics and mechanism of desulfurization and denitrogenation of coal-derived liquids. Eleventh quarterly report, December 21, 1977-March 20, 1978.** Gates, B.C.; Katzer, J.R.; Olson, J.H.; Kwart, H.; Stiles, A.B. (Delaware Univ., Newark (USA)). 20 May 1978. Contract EX-76-C-01-2028. 68p. Dep. NTIS, PC A04/MF A01.

Three high-pressure flow microreactors and two batch autoclave reactors have been used to study the reaction networks and kinetics of (1) catalytic hydrodesulfurization of dibenzothiophene and methyl-substituted dibenzothiophenes, and (2) catalytic hydrodenitrogenation of quinoline, methyl-substituted quinolines, acridine, benzacridines, dibenzacridine, and carbazole. The catalysts were commercial, sulfided $CoO-MoO_3/\gamma-Al_2O_3$, $NiO-MoO_3/\gamma-Al_2O_3$, and $NiO-WO_3/\gamma-Al_2O_3$. The results of the experiments are described. (LTN)

2378 (FE—2028-15) **Kinetics and mechanism of desulfurization and denitrogenation of coal-derived liquids. Thirteenth quarterly report, June 21-September 20, 1978.** Gates, B.C.; Katzer, J.R.; Olson, J.H.; Kwart, H.; Stiles, A.B. (Delaware Univ., Newark (USA)). 16 Mar 1979. Contract EX-76-C-01-2028. 134p. Dep. NTIS, PC A07/MF A01.

Studies of competing hydroprocessing reactions catalyzed by $Ni-Mo/\gamma-Al_2O_3$ and involving quinoline, indole, dibenzothiophene, and naphthalene in n-hexadecane show that marked interactions exist. The naphthalene hydrogenation rate is markedly reduced by the presence of quinoline; whereas the reactivity of quinoline is virtually unchanged by the presence of naphthalene. Similarly the rate of hydrodenitrogenation of indole, a non-basic nitrogen-containing compounds is strongly reduced by the presence of quinoline, whereas the rate of hydro-denitrogenation of quinoline, a basic nitrogen-containing compound, is unaffected by the presence of indole. The hydrogenation reactions in the dibenzothiophene reaction network are inhibited severely as indicated by the reduction in their pseudo first-order-rate constants as are the hydrogenation reactions for naphthalene. Thus the hydrogenation rate is reduced 30-fold by increasing the initial quinoline concentration from 0.0 to 0.5 wt % in naphthalene hydrogenation and in dibenzothiophene hydrodesulfurzation. The rate of direct sulfur removal is reduced by only 3-fold by increasing the quinoline concentration from 0.0 to 0.5 wt %. These results clearly show that the rate expressions for the hydrotreating reactions are of the form given in the text.

2379 (LBL—9963) **Oxydesulfurization of coal by acidic iron sulfate solutions.** Mixon, D.A.; Vermeulen, T. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Oct 1979. Contract W-7405-ENG-48. 13p. Dep. NTIS, PC A02/MF A01.

To facilitate by-product recovery and eliminate elemental sulfur formation, a high-sulfur bituminous coal (Illinois No. 6) has been treated with aqueous ferric sulfate/sulfuric acid and oxygen at 100 to 150°C for pyrite removal. Conversions up to 56% in 1 hour have been obtained with -20/+35 mesh coal at 280 psi of oxygen. Relatively complete pyrite removal by this method appears feasible; also, the possibility exists of extending the method to remove at least part of the organic sulfur present.

2380 **Method of processing technical gases.** Beise, H.; Schlicht, B.; Thiele, M.; Gross, M.; Minak, H.P.; Schingnitz, M.; Wehner, K.; Burk, W. US Patent 4,145,192. 20 Mar 1979. Priority date 23 Feb 1976, German, Federal Republic of (F.R. Germany), 6p.

The invention described is a method for simultaneously purifying and drying technical gases such as natural or synthetic gas by the use of a nonaqueous solvent. The gases containing water vapor, acid gases, neutral sulfur compounds, and/or higher hydrocarbons

can be cleansed by contacting them with an anhydrous solvent containing 60 to 90% N-methyl-ε-caprolactam, 5-60% of a glycol, and 0-30% of alkanolamine by wt. 6 claims.

GASIFICATION

REFER ALSO TO CITATION(S) 2422, 2429, 2434, 2457, 2466, 2473, 2710, 2898, 2903, 2934, 3191, 3192, 3317, 3356, 3455

2381 (ACD—38391-18) **Investigation of high velocity wedge separator for particle removal in coal gasification plants. Quarterly report, February 1-April 30, 1979.** Linhardt, H.D.; Beveridge, J.H.; Boone, C.G. (Airco Cryogenics, Irvine, CA (USA)). 30 Apr 1979. Contract EF-77-C-01-2709. 35p. Dep. NTIS, PC A03/MF A01.

Phase IA and II are proceeding concurrently and are leading to meaningful results meeting the basic contract objectives. As a matter of fact low pressure loss HTPS configurations have been demonstrated with the AAM and high temperature particle collection of 1 micron radius particles has already been observed by several demonstration firings with hot gas temperatures above 1800°F and pressures close to 400 psia. Future high temperature and high pressure testing is directed toward accurate measurement of the HTPS collection efficiency and identification of the physiochemical changes particles are undergoing at high temperature conditions. It appears that the hot gas test method in conjunction with the AAM effort will provide a valuable and needed understanding of particulate separation applicable to high temperature and high pressure gasifiers.

2382 (BMFT-FB-T—79-05) **Pressure-change underground gasification: theoretical and experimental investigations of gasification.** Beckervordersandforth, C.P.; Belzer, J.; Kuehn, M.; Mohtadi, M.; Sitte, W.; Sublkew, G.; Terschueren, W. (Technische Hochschule Aachen (Germany, F.R.). Inst. fuer Eisenhuettenkunde). Jun 1979. 93p. (In German). Dep. NTIS (US Sales Only), PC A05/MF A01.

A program is described for the extraction of SNG, reducing gas or other gaseous fuels by means of in-situ coal gasification with hydrogen, air and oxygen mixtures, particularly in deeper deposits, with special regard to the pressure change process. Simulation experiments above ground and a feasibility-study will be carried out.

2383 (CONF-781231—, pp 307-314) **Evaluation of prestressed cast iron pressure vessels (PCIV) for coal gasification.** Thompson, R.E. (Westinghouse Advanced Energy Systems Div., Pittsburgh, PA). 1979.

From 3. annual thermal energy storage contractor's information exchange meeting; Springfield, VA, USA (5 Dec 1978).

The approach being followed in this study is to define representative top level requirements, derive and analyze a gasifier PCIV conceptual design, evaluate the applicability of existing technology, identify the ASME code modification that would be required to cover this type of vessel, and compare the PCIV characteristics to those of welded steel and prestressed concrete vessels for coal gasifiers. In addition, the results will be interpreted in the context of their applicability to high temperature thermal energy storage applications. The project status is as follows: (1) top level requirements for the PCIV have been identified for the reference application of a Bi-Gas process gasifier to 55,000 ton per day coal capacity; (2) a preliminary conceptual design for the PCIV has been defined and is being analyzed in order to arrive at a final conceptual design. Appropriate materials and their characteristics have been defined to support concept definition and evaluation; (3) recommended ASME code modifications are in the process of being defined; (4) evaluation of the PCIV characteristics have been initiated.

2384 (DOE/EV—0046(Vol.1), pp 376-392) **Wastewater treatment technology for coal conversion plants.** Klein, J.A.; Brown, C.H.; Lee, D.D. (Oak Ridge National Lab., TN). Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

Data on the treatment of aqueous coal conversion waste are needed to ensure that water supply and quality are not adversely affected by the developing coal conversion industry. This work is not intended to develop new wastewater treatment processes, but to provide useful and timely information on the application of known control technologies to coal conversion wastewaters. Samples of lignitic coal and steam-plant fly ash have been tested for their ability to remove polyaromatic hydrocarbons (PaHs) and refractory phenolics from aqueous streams. Removal of up to 99% of the organics was obtained with solid loadings as high as 15 mg/g. In experiments with a tapered, fluidized-bed bioreactor, phenol reductions of ~ 99.9% were achieved at phenol degradation rates of 7 to 10 kg per day per m^3 of reactor volume. Ozonation tests have shown that, with biologically treated wastewater, 99% of the residual phenol and 22 to 97% of the refractory PAHs, along with most of the associated colors and odors, can be degraded using ozone dosages of 0.01 to 0.14 kg per thousand liters. Experiments using wet oxidation for the destruction of both soluble and absorbed organics have been initiated.

2385 (DOE/EV—0046(Vol.1), pp 441-463) **Environmental control assessment of entrained flow gasifiers: commercial control systems.** Sealock, L.J. Jr.; Mudge, L.K. (Battelle Pacific Northwest Labs., Richland, WA). Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

Several conclusions may be drawn from this study: coal storage, preparation and drying processes are commercially available. Sulfur and particulates are completely removed from the product gas in the commercial operations as required for use of the gas for chemical synthesis. These systems have been in use for over 40 years. Claus plants are employed in some of these commercial operations to convert the sulfur compounds to environmentally acceptable elemental sulfur. Reduced H_2S concentration in stripped gases to the Claus plant will reduce efficiency for sulfur recovery. Tail-gas cleanup processes for reduction of Claus plant emissions and increasing sulfur recovery are available. Major energy users in the processes are oxygen production, acid gas removal, and gas compression. Since essentially no tars or hydrocarbons are produced in entrained flow gasification processes, water cleanup problems are minimal and should cause no unique waste water treatment problems for conventional water treatment methodologies. Dissolved compounds such as NH_4, H_2S and HCN and leached trace elements are the contaminants of concern. Waste water will be cleaned and recycled for process use. Chronic loss of water results from direct contact cooling tower operation. Control of losses from evaporative cooling towers is a major concern. Large quantities of ash and slag will be generated with commercial gasification processes. An assessment of ash compositions and ash disposal techniques should be undertaken to determine the adequacy of current control methodologies. Although much information has been written about coal gasification processes, there are many areas in which data is lacking in the environmental aspects of the processes.

2386 (DOE/EV—0046(Vol.1), pp 465-484) **Improved water management of coal conversion processes by preliminary absorption of halides.** Parsons, W.A. (Arthur G. McKee and Co., Cleveland, OH). Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

Quench water is a principal wastewater from coal conversion processes that employ wet cleaning of gases. The origin of the water is moisture in the coal and steam injected into the coal conversion reactor. Depending upon coal composition the quench water contains chlorides, fluorides, ammonia, hydrogen sulfide and sulfur oxides. With tar producing coal conversion technology, the quench water also contains cyanides, thiocyanates, phenols and various organics. A two stage gas quenching process was proposed to absorb strong electrolytes in a small flow first-stage quench so as to improve the feasibility of reuse of the larger volume second-stage quench. A study was made to compare the technical and economic feasibility of two-stage quenching with conventional single-stage quenching. The study evaluated methodology for estimation of quench water characteristics and engineered a concept for accomplishment of the two-stage quench. The results indicated that strong electrolytes could be absorbed from the gases to a high degree in a first-stage quench with a blowdown of from 5 to 10 percent of the total condensate. The blowdown would be purged to waste disposal. The second-stage quench would collect 90 to 95 percent of the condensate containing a low content of strong electrolytes. The condensate containing weak electrolytes and organics would be treated by steam stripping and bioxidation prior to reuse as process water. Alternative disposal concepts were evaluated for two sites using representative Eastern and Western coals.

2387 (DOE/EV—0046(Vol.1), pp 485-502) **Environmental control activities on slagging fixed-bed gasification at the Grand Forks Energy Technology Center.** Ellman, R.C.; Sondreal, E.A. (Dept. of Energy, Grand Forks, ND). Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

The 25-TPD pilot SFBG at the GFETC was reactivated in 1976 for the purpose of supporting the development and commercialization of the slagging fixed-bed gasification process. A major objective was the development of a detailed environmental assessment, including characterization of both gaseous and liquid effluents. This assessment will substantially apply both to the Hi-Btu demonstration plant currently being designed based on SFBG technology and to fixed-bed, dry-ash Lurgi gasifiers planned for first generation SNG plants. The work contained in the environmental assessment plan for the GFETC/SFBG will include the following: (1) an analysis of the strategic approach required to meet industrial and regulatory needs; (2) development and application of sampling procedures and analytical methods for characterizing gaseous and liquid effluents; (3) studies on gas cooling, separation of tar and byproducts, and treatment of waste water; (4) studies on disposal of gasifier

slag and other waste solids; (5) the relation of effluent properties to gasifier operating variables, and (6) assessment of biomedical effects due to tars and waste water constituents. This report will present a summary of the assessment plan and selected data on the characterization of gaseous and liquid effluents performed to date.

2388 (DOE/EV—0046(Vol.1), pp 503-519) **Overview of the SYNTHANE pilot plant environmental assurance program.** Ladesic, R.P.; Scott, R.L.; Peters, W.C. (Dept. of Energy, Pittsburgh, PA). Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

An historical account of the development and current studies of environmental monitoring and compliance at the SYNTHANE pilot plant will be presented. This account will include the experiences and problems in establishing environmental monitoring programs. In February and Marcn 1975 the first ambient air background studies were undertaken at the SYNTHANE pilot plant. Subsequent to these initial studies an environmental monitoring and compliance program was developed. The cost of this program to date plus facilities and equipment amount to approximately three million dollars. The experience provided in interfacing with the technology development and developing the environmental monitoring and compliance program can be of value to all who are involved in small scale and large scale development.

2389 (FE—1784-48) **Program to discover materials suitable for service under hostile conditions obtaining in equipment for the gasification of coal and other solid fuels. Annual progress report, January 1-December 31, 1978.** Schaefer, A.O. (ed.). (Metal Properties Council, Inc., New York (USA)). 8 May 1979. Contract EX-76-C-01-1784. 355p. Dep. NTIS, PC A16/MF A01.

This Annual Report describes in general the progress during Calendar Year 1978, on a program under the direction of The Metal Properties Council, Inc., designed to screen materials for use in such plants with respect to the various unique corrosive environments obtaining therein; and, finally, to provide useful corrosion data as well as reliable information on other properties needed for the design, construction and operation of such plants. This program is sponsored by the US Department of Energy and the Gas Research Institute. The program is being pursued in seven phases. The actual laboratory testing for the first four phases is being conducted at the IIT Research Institute. The testing necessary for Phase V is being conducted principally at the Southwest Research Institute. The entire program is being monitored by Subcommittee 9 on Materials for the Gasification of Coal of The Metal Properties Council, Inc. A summary of achievements during Calendar Year 1978 under each phase follows. There have been four Annual Reports and fifteen Quarterly Reports preceding this Report.

2390 (FE—1784-48(App.)) **Program to discover materials suitable for service under hostile conditions obtaining in equipment for the gasification of coal and other solid fuels: appendices. Supplement to annual progress report, January 1-December 31, 1978.** (Metal Properties Council, Inc., New York (USA)). 8 May 1979. Contract EX-76-C-01-1784. 219p. Dep. NTIS, PC A10/MF A01.

2391 (FE—2338-13) **Development of a modular software system for the dynamic simulation of coal conversion plants.** Schiesser, W.E.; Stein, F.P.; Johnson, S.H.; Caram, H.S.; Dissinger, G.R. (Lehigh Univ., Bethlehem, PA (USA)). Apr 1979. Contract EX-76-C-01-2338. 135p. Dep. NTIS, PC A07/MF A01.

Two manuals have been appended to this report which give an introduction, a description, the coding, and some sample output for the (1) dynamic hydrogen plant model, and (2) dynamic pyrolyzer model. As part of our continuing effort to have available the most effective temporal integrators for ordinary differential equations, a recent revision of GEARS by A.C. Hindmarsh and the new GEARZ by M.B. Carver were added to our library of integrators. Both GEARS and GEARZ are based on the latest developments in sparse matrix manipulation of the problem system Jacobian matrix. The Ziegler-Nichols control settings for the proportional-only hot-gas bypass flow controllers on the interstage waste-heat boilers and feedwater preheaters in the bulk methanation model have been calculated. The dynamic bulk methanation model with interstage heat exchangers and controllers was successfully executed using the implicit integrator GEARB. The heat exchanger models are several orders of magnitude faster than the reactor models. Thus, the addition of the heat exchanger models to the reactor models considerably stiffened the set of ODEs. When hot-gas bypass flow controllers on the interstage heat exchangers were added, the numerical integration efficiency was significantly decreased. One explanation is that the controller equations stiffened the overall simulation. Another possibility is that the controller equations spread the heretofore banded system Jacobian. Investigation of the actual case is continuing. The cleanup methanator has been added to the dynamic hydrogen plant and run successfully.

2392 (FE—2340-1A) **Improved techniques for gasifying coal. First annual report, July 1, 1976-June 30, 1977.** Graff, R.; Yerushalmi, J. (City Coll., New York (USA)). Jul 1977. Contract EX-76-S-01-2340. 123p. Dep. NTIS, PC A06/MF A01.

A thorough study of the various fluidization regimes and the transitions between them was carried out. The experiments were conducted in the 6-inch system. The results show that as the velocity across a bubbling (slugging) bed is slowly raised, the structure of the bed changes from a pronounced bubbling condition to a turbulent state in which large bubbles or voids are absent. The transition from bubbling to turbulent fluidization was fairly sharp for FCC, and more gradual for HFZ-20 and Dicalite. For FCC, the turbulent regime extends from 2 ft/sec to a velocity around 5 to 6 ft/sec. Beyond that velocity, a high solid concentration, typical of the fast bed condition, can be maintained in the column only if the solid circulation rate is sufficiently high. Experiments were conducted to study the extent of gas backmixing in a bed of FCC fluidized at gas velocities spanning the bubbling, turbulent, and the fast bed regimes. The results show that the degree of gas backmixing is high in the bubbling regime; it diminishes, though it might still be appreciable, over the turbulent regime, and gas is essentially in plug flow in the fast fluidized bed. The backmixing data for the turbulent range lends itself to a simple countercurrent backmixing model. Other experiments involved the flash hydrogenation of several US coals and flash hydrolysis with steam at high pressure. (LTN)

2393 (FE—2468-44) **Guidelines for economic evaluation of coal conversion processes. Final report on Task 010.** McBeath, B.C. (Engineering Societies Commission on Energy, Inc., Washington, DC (USA)). Apr 1979. Contract EF-77-C-01-2468. 83p. Dep. NTIS, PC A05/MF A01.

These guidelines were developed for use in preparing and reporting engineering designs, cost estimates and financial analyses of large-scale fossil energy facilities. They provide a uniform basis for presenting project expectations so that comparison between alternative projects can be done on a consistent basis and thereby assist in the establishment of technical development priorities. The guidelines are primarily for the preliminary economic analysis of coal conversion projects, producing either gas or coal liquids. In a preliminary estimate, the process, equipment and site factors are sufficiently defined to justify a preliminary engineering design. However, the general structure and subject matter of these guidelines are applicable to either more simplified or more detailed analyses of energy facilities. The guidelines are organized by types of information needed in evaluating the economics of a project. Documentation of specific items relating to project scope, process design, capital and operating cost estimates and financial analyses is required to aid in assessing and interpreting reported results. Particular emphasis is placed on the treatment of capital cost estimates of new processes at various stages of technical development. Also, the financial methods and parameters to be used in determining the required selling price of products are defined in order to establish a base case for sensitivity analysis of technical, locational or financial variables. In addition, an appraisal of the results is requested of those responsible for preparing the project evaluation report.

2394 (FE—2542-15) **Phase I: the pipeline gas demonstration plant. Quarterly technical progress report, 1 October-31 December 1978.** Sweany, G.A. (Comp.). (Continental Oil Co., Stamford, CT (USA)). 1978. Contract EF-77-C-01-2542. 22p. Dep. NTIS, PC A02/MF A01.

Contract No. EF-77-C-01-2542 between Continental Oil Company and the US Department of Energy requires Continental Oil, as Contractor, to design, construct, and operate a Demonstration Plant capable of converting bituminous caking coal into pipeline quality gas. Work under this contract is divided into three phases: Development and Engineering; Demonstration Plant Construction; and Demonstration Plant Operation. Work on Phase I started on July 1, 1977, and was originally scheduled to be completed on April 30, 1979. DOE, however, subsequently deferred all engineering design work on the Demonstration Plant and stipulated that other work activities be continued at a reduced pace. This slowdown continued during the current reporting period. Work was limited to collection of site data, collection of environmental data, and a reassessment of the basis of design for the Demonstration Plant. DOE is in the process of re-evaluating the pipeline gas demonstration program. The project is expected to continue at a slowdown pace until this re-evaluaion has been completed.

2395 (FE—2616-T1) **Coal pump development. Phase I feasibility report.** Schatz, W.J.; Carpenter, E.G.; Daksla, C.S.; England, C.; Feinstein, S.P.; Kushida, R.O.; Lewis, D.W.; Lloyd, W.G.; Sankur, V.D. (Jet Propulsion Lab., Pasadena, CA (USA)). Sep 1978. Contract EF-77-A-01-2616. 224p. Dep. NTIS, PC A10/MF A01.

Having confirmed that coal could be extruded through a small orifice, a small, used, thermoplastics extruder was procured and modified by increasing the size of the heaters. The extrudate expelled from the extruder was in the form of long, curly, thin (1/4 in.) spaghetti or large, expanded, foamy, billowy masses. Based on

these results, the present program was implemented to expand the engineering base of extrusion. A standard 2.5 in. single-screw extruder was procured from the Egan Machinery Company. This machine was identical to that used for plastics except that the maximum capacity heaters available were installed and the profile of the screw was modified slightly based on the 1.5 in. experience. In conjunction with this effort, work was initiated to characterize the properties and rheology of coals and their xtrudates, and to model the coal pump to aid in understanding the fundamentals of coal extrusion and to aid in scaling to pump sizes compatible for use in commercial-size coal conversion plants. After modifications had been incorporated into a thermoplastics type of capillary viscometer, the viscosity of plastic coals was measured. The apparent viscosities ranged from a low of one poise for Pittsburgh No. 8 (equal to viscosity of SAE 10 oil at 60°F) up to 1000 poise for Kentucky No. 9 coal. Both of these coals have been extruded through the 1.5 in. coal pump. The modelling effort has been able to utilize a computer program developed for the thermoplastics industry to model coal extrusion.

2396 (FE—2700-4) **Heat transfer in a fluidized counter current bed. Annual report, July 1977-July 1978.** Jackson, R. (Houston Univ., TX (USA)). Aug 1978. Contract EF-77-S-01-2700. 23p. Dep. NTIS, PC A02/MF A01.

An apparatus has been designed and constructed to investigate the downflow of larger and/or denser particles through a fluidized bed of smaller and/or less dense particles. The apparatus permits bed expansion and bed load to be changed, and for each set of conditions the dependence of the holdup of the descending particles on their feed rate can be determined. A complete set of measurements for one pair of particle types, namely crushed limestone and polystyrene beads, has now been completed, and work is continuing on the influence of the density and size of the descending particles on the behavior of the system.

2397 (FE—3182-T2) **Waste disposal, cooling and related environmental impacts associated with synthetic fuel plant siting and design criteria. First quarterly report, August 8-December 31, 1978.** Gold, H.; Goldstein, D.; Seufert, F.; van Wormer, K. (Water Purification Associates, Cambridge, MA (USA)). 1978. Contract ET-78-C-01-3182. 20p. Dep. NTIS, PC A02/MF A01.

During the First Quarter work was directed in two areas: (1) to determine the consumption of water for cooling in coal conversion plants, and (2) to evaluate water environmental control technologies in coal conversion plants. In the first area three cooling loads were studied: Interstage coolers in gas compressors, cooling steam turbine condensers, and regeneration condensers and other cooling in acid gas adsorption sections. Results are presented for the water consumed as a function of the cost of water. This task is complete. Details of the calculations are given in an attached addendum. The second task is partially complete. The thermosludge pprocess for direct generation of steam from dirty condensate is undergoing evaluaion. The preliminary conclusion is that the rocess has considerable merit and potential for reducing both the capital and energy costs which would otherwise be required for more conventional processes to separately treat the condensate and generate process steam.

2398 (METC/CR—79/16) **Reactivity of iron sulfide in sulfur dioxide atmosphere.** Wen, C.Y.; Tseng, S.C.; Tone, S. (West Virginia Univ., Morgantown (USA). Dept. of Chemical Engineering). Sep 1979. 36p. Dep. NTIS, PC A03/MF A01.

Desulfurization of low-Btu gas at elevated temperatures has been receiving much attention in recent years. The direct use of metals and their oxides to remove hydrogen sulfide from a hot synthesis gas produced by coal or residual oil gasification has offered one such method in improving process efficiency. Hasatani and Wen studied the reactivity of iron oxide with hydrogen sulfide in the presence of hydrogen and carbon monoxide. In order to design the clean-up process for coal-based fuel gases, kinetic studies of the regeneration of iron sulfide are necessary. In this work, the reactions of iron sulfide in a mixture of sulfur dioxide and nitrogen were carried out in a thermogravimetric analyzer to determine the reactivities of solid-gas system for the design of a fixed bed and a fluidized bed reactor. The ultimate capacities and the reaction rates of iron-sulfide sorbents with sulfur dioxide were measured based on the weight change and the time derivative of the weight change of specimen used.

2399 (METC/SP—79/7) **Assessment of catalytic gasification.** Prasher, B.D. (Department of Energy, Morgantown, WV (USA). Morgantown Energy Technology Center). Jan 1979. 100p. Dep. NTIS, PC A05/MF A01.

This report deals with different aspects of catalytic gasification phenomena and processes, and attempts to assess a number of these on the basis of the possible mechanisms that may be involved. In this way parameters and variables important in catalytic gasification schemes are identified. Some conclusions and recommendations on the need to broaden the current data base and to direct investigations into certain areas in catalytic gasification are presented.

2400 **Status of the fourth underground coal gasification experiment at Hanna, Wyoming.** Bartke, T.C.; Dockter, L.; Sterner, T.E.; Virgona, J.E. New York, NY; American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc. (1978). 10p. (CONF-781003—7).

From 53. annual technical conference and exhibition of society of petroleum engineers; Houston, TX, USA (1 Oct 1978).

The fourth underground coal gasification experiment conducted by the Laramie Energy Technology Center is currently underway at a site near Hanna, Wyoming. The Hanna IV experiment, as originally conceived, was significantly larger than the three previous experiments. The experiment was designed to meet the following objectives: determination of the interrelationships of well spacing, air injection rate, and areal sweep efficiency; demonstration of the ability to conduct reverse combustion linkage over distances up to 45.7 m (150 feet); determination of pressure and gas composition gradients within the coal seam during process operation; determination of gasification zone progress as a function of time; and demonstration of relaying the process down a row of process wells. A portion of the technology development has involved environmental assessment of the process. This assessment included characterization of the effluents from the process as well as initiation of biological effects studies and determination of the fate of pollutants from the process. Major concerns associated with the process are impacts on air and ground water quality and the effects of subsidence. This paper describes the initial phase of the Hanna IV experiment in which difficulties were encountered and a sustained gasification process could not be maintained. An override situation across the 30.5 m (100-foot) well spacing resulting in a premature shutdown of the experiment. Preparations are being made to continue the experiment and recover from the override situation.

2401 (SAND—79-0449) **Fields from a vertical magnetic dipole beneath a layered earth.** Caffey, T.W.H. (Sandia Labs., Albuquerque, NM (USA)). Sep 1979. Contract EY-76-C-04-0789. 23p. Dep. NTIS, PC A02/MF A01.

Both the E and H fields from a vertical magnetic dipole placed in the third layer of a three-layer earth are derived. The results are applied to transmission beneath two Wyoming coal seams to see the effects of the overburden upon the voltage induced in a horizontal loop which is coplanar with the dipole. Beneath each seam, the effects of the overburden can be neglected when both the dipole and loop are at least one meter below the seam and when the operating frequency is less than 15 kHz.

2402 **Tri-Gas gasification process.** Colaluca, M.A.; Paisley, M.A.; Mahajan, K. (Bitum Coal Res, Inc, Monroeville, Pa). *Chem. Eng. Prog.;* **75**: No. 6, 33-40(Jun 1979).

This paper describes the newly developed Tri-Gas process, a multiple fluid-bed coal gasification system, which has been designed to gasify a range of coals with the only product being a clean, low-heat content fuel gas. No liquids, tar, or char are produced as a waste or byproduct. The process consists of three, fluidized-bed reactors connected in series. Each reactor has its own specific function. Stage 2 is the main gasification stage. Here, devolatilized coal (char) and the volatile products from Stage 1 are gasified with air and steam, producing a fuel gas of about 150 Btu/cu ft (5,586 kJ/m;sup 3;). Unreacted char flows out of Stage 2 to Stage 3, where the remaining carbon is consumed. Stage 3 off gas is directed to Stage 1 to provide heat for a low temperature devolatilization of the feed. Stage 1, in turn, produces a free-flowing, devolatilized char to Stage 2, while accepting coal as a feed. Success of laboratory studies led to the design of a 0.01 kg/s process and equipment development unit (PEDU), which was designed to demonstrate the technical feasibility of the Tri-Gas gasification process for the commercial production of low-heat content fuel gas. Technological details are given along with some design suggestions.

2403 **Synthetic gas production.** Wintrell, R. (to Arthur G. McKee and Co.). US Patent 4,153,426. 8 May 1979. Filed date 18 Jul 1977. 16p.

Disclosed is a method and apparatus for producing synthetic gas by using a blast furnace as a gasifier. The furnace is charged in a conventional manner with particles of solid carbonaceous material such as normal, low grade or undersized coke together with slag-producing material, such as limestone, silica and/or basic oxygen furnace and/or open hearth furnace slag. Fluent fuel such as pulverized coal mixed with oxygen-containing gas and with lime if desired is injected into pre-ignition chambers near the hearth line of the furnace. The fluent fuel is ignited and partially gasified in the pre-ignition chambers, creating a hot reducing gas that enters the furnace raceway and passes upwardly into and through the body of charge material in the furnace stack. At the resulting high temperatures ash from the fluent fuel liquifies within the system to provide a liquid slag. Under a controlled high temperature reducing atmosphere, the liquid lime removes essentially all sulfur from the product gas. 41 claims.

2404 Two-dimensional pyrolysis effects during in-situ coal gasification: preliminary results. Forrester, R.C. III; Westmoreland, P.R. (Oak Ridge Natl Lab, Tenn). *J. Pet. Technol.;* **31**: No. 5, 571-573(May 1979).

This short article describes progress on an experimental study related to underground gasification of coal. This study investigates two-dimensional pyrolysis systems using large, instrumented blocks of subbituminous coal from Wyoming. The effects of reactive gases from the gasification zone are included in the study. Correlation of the experimentally determined char, tar, and gas yield and composition with maximum reactor temperature and heating rate are discussed.

2405 Thermodynamic analysis of coal gasification processes. Singh, S.P.; Weil, S.A.; Babu, S.P. Chicago, IL; Institute of Gas Technology (1979). 18p. (CONF-790886—1).

From Second law of thermodynamics workshop; Washington, DC, USA (14 Aug 1979).

Thermodynamic analysis to evaluate and improve coal gasification process efficiency requires estimation of enthalpy, entropy, and availability transformations in various process steps. A compilation of procedures and data relevant to coal gasification processes is presented for calculating the above thermodynamic properties. Enthalpy and availability transformations are estimated for significant process steps in the HYGAS process for producing substitute natural gas from coal. The thermal efficiencies based on the first law of thermodynamics are compared with the availability efficiencies based on the second law. Work intensive process steps, such as gas compression and separation, have extremely low thermal efficiencies and fairly high availability efficiencies. Heat intensive process steps, such as steam generation, have high thermal efficiencies but generally poor availability efficiencies.

2406 Behavior of eastern and western coals in fuel-rich reaction conditions. (Avco Everett Res Lab, Inc, Mass). pp A.5.1-A.5.4 of Engineering aspects of magnetohydrodynamics, 1978. Ubhayakar, S.K.; Gannon, R.E.; Stickler, D.B. Stanford, CA; Stanford Univ. (1978).

From 17. symposium on engineering aspects of MHD; Stanford, CA, USA (27 Mar 1978).

This paper addresses the gasification behavior of two coals of different ranks in a hot reducing atmosphere simulating conditions representative of high energy coal gasifiers or of the first stage of two-stage MHD combustors. The experiments conducted in an entrained flow gasifier are described and the data on the temperatures and on the gasification yields are analyzed.

LIQUEFACTION

REFER ALSO TO CITATION(S) 2377, 2378, 2384, 2393, 2395, 2397, 2420, 2423, 2424, 2428, 2536, 3191, 3192, 3423, 3455

2407 (DSE—3047-T2) **Temperature profiles in donor solvent liquefaction. Quarterly technical report No. 2, December 1978-February 1979.** McIntosh, M.J. (Eyring Research Inst., Provo, UT (USA)). 1979. Contract ET-78-C-01-3047. 48p. Dep. NTIS, PC A03/MF A01.

Experimental progress has concentrated on equipment fabrication. A reactor heating system capable of raising the temperature of the coal/solvent mixture 25°C per minute has been designed and built. The system incorporates two heated tanks. Molten heat transfer salt (HITECH) is forced from one tank, through a high temperature heater, through the internal cooling coils of the reactor and then into the other tank. The direction of flow is reversible so heating can be continued indefinitely. Use of this device along with the water quench system will enable nearly any conceivable temperature profile to be studied experimentally. A chromatograph involving sequential elution on silica gel (SESC) has been fabricated. This instrument and technique was developed at the Mobil Oil Company Research Laboratories. Briefly the instrument automates the fractionation of coal derived liquids on a silica gel column using a sequence of nine different solvents. The nine fractions obtained are distinctive, especially with regard to functionality. Coal derived liquids including asphaltenes and preasphaltenes, can be characterized in detail using this technique. It will be used to detail the differences in the coal derived liquids obtained from various different temperature profiles. Considerable progress has been made in mathematical modeling. A computer code capable of solving complex chemical reaction equations of any number of reactants and products has been programmed and made operational.

2408 (EPRI-AF—1158) **Process development for improved SRC options: interim short residence time studies.** Kleinpeter, J.A.; Burke, F.P.; Dudt, P.J.; Jones, D.C. (Conoco Coal Development Co., Library, PA (USA). Research Div.). Aug 1979. 194p. Dep. NTIS, PC A09/MF A01.

The maximum conversion achieved in 14 continuous runs with Indiana V coal and Wilsonville based solvents was 80% MAF to THF solubles (85% to cresol solubles). No hydrogen gas was used and the pressure was 500 to 600 psig. Hydrogenated Wilsonville solvent gave better performance than the neat solvent at comparable Θ_{600} and anti T_{600} in the bench-scale tests. Liquefaction solvent deficits of 4 to 28% MAF coal imply considerable solvent polymerization. Polymerization was greater with the neat solvent and at higher solvent/coal ratios. SRC sulfur content was 1.5 to 2.0 wt % and varied inversely with $THETA_{600}$ and anti T_{600}. Over 100 runs were made in a 30 ml microautoclave which can be rapidly heated and quenched. THF conversions were 80 to 85% MAF under a wide range of extraction conditions. Hydrogenated Wilsonville solvents performed better than the neat solvent (8.0% H) but the hydrotreated solvents (8.6 to 9.2% H) each gave the same results. Microautoclave extractions made at 750°F, 30 min, 2.0 solvent/coal indicated the relative donatable hydrogen content of various liquefaction solvents. Microautoclave results agreed reasonably well with continuous unit performance when residence time and temperature were matched. The continuous and microautoclave studies were performed to provide preliminary information on a potentially improved SRC process devised by EPRI. The process combines short residence time liquefaction, critical solvent deashing and hydrogenation of liquefaction solvent, polymerized solvent and the lower molecular weight fraction of coal extract.

2409 (FE—1517-78) **Coal liquefaction test center. Quarterly technical progress report, October-December 1978.** (Fluor Engineers and Constructors, Inc., Irvine, CA (USA)). Jun 1979. Contract EX-76-C-01-1517. 69p. Dep. NTIS, PC A04/MF A01.

Repairs from the damage incurred during the August fire were completed in mid-November. At that time the major modifications to the J-A608C/D hydrogenation reactor recycle pumps also had been completed. During December integrated operation of the Cresap Pilot Plant was carried out for two periods of 24 and 40 hours during Runs 014 and 015. Extraction operations in the front end totaled 37 and 7 hours for these runs. On stream hydrogenation time in Section 600 consisted of 154 hours processing feedstock from storage and 64 hours on fresh extract. Because of the short periods of stabilized operation, characterization data collected were minimal. However, it is estimated that depth of extraction was about 75% on MAF coal during each run. Hydrogenation effected about 80% conversion of +880°F material and 60% sulfur reduction in final product. In the slurry preheater tests, slurries up to a maximum concentration of 37 wt. % at rates up to 20 tpd of coal were successfully handled. Two heating tests were conducted on mixtures of solvent and heavy fuel oil product to evaluate their thermal stability. One mixture contained 10 wt. % and the other 20 wt. % +880°F boiling range hydrogenated material. No evidence of coking was observed in either test. Severe erosion of the J-A313 feed pumps (to solids separation) continued to be noted but a solid Stellite Number 6 impeller has given good service. Substitution of Kalrez for Viton in the O-rings of the inboard seal of double mechanical seals has given substantially improved performance in 550 to 750°F service.

2410 (FE—1743-68) **Zinc halide hydrocracking process for distillate fuels from coal. Annual technical progress report, February 1, 1978-January 31, 1979.** Zielke, C.W.; Pell, M.; Greene, C.R.; Maskew, J.T.; Struck, R.T. (Conoco Coal Development Co., Library, PA (USA). Research Div.). 15 May 1979. Contract EX-76-C-01-1743. 105p. Dep. NTIS, PC A06/MF A01.

Construction of the 1.2 TPD (1090 kg/day) Process Development Unit (PDU) was completed in mid-1978. Break-in of the Liquefaction and Fractionation Sections were completed by August 31, 1978. Once-through runs in the Liquefaction (Hydrocracking) Section were made with heavy aromatic distillate and with Ft. Lewis Solvent Refined Coal (SRC-I), diluted with distillate. Run 4, feeding SRC-I and recycled heavy distillate product at full design rate is underway. Preliminary yields generally agree with predictions from bench-scale work. A number of equipment failures have prevented extended runs, and revisions are planned to correct this. These will be implemented while the Regeneration Section is broken-in and operated separately. Final results from the continuous bench-scale work showed that single-stage liquefaction of Montana subbituminous coal can be operated up to 427°C (825°F) and in multiple-stage operation, the final stage at 17.5 MPa (2500 psig) can be as high as 496°C (925°F) without coke formation. This will permit increased throughput and eliminate a melt extraction step in the process. A study of crushing and drying of subbituminous coal showed that the oxygen level in the drying gases can be controlled to a level where no degradation of the coal results. Coal for the projected program has been crushed and dried. An economic study comparing direct coal feeding with producing SRC-I and feeding it to zinc chloride processing showed an incentive for direct coal feeding.

2411 (FE—2038-25) **Commercial scale expanded bed hydroprocessing of Solvent Refined Coal (SRC) extract. Interim technical progress report on Subtask I: catalyst screening.** Potts, J.D.; Hastings, K.E. (Cities Service Co., Tulsa, OK (USA). Technology Assessment

Dept.). Aug 1978. Contract EX-76-C-[illegible]-2038. 72p. Dep. NTIS, PC A04/MF A01.

The feasibility of utilizing an expanded bed reactor (LC-Fining Process) for upgrading SRC-I has been adequately demonstrated with respect to conversion of 850°F+ and desulfurization. The objective of this subtask was to determine the effectiveness of commercially available hydrotreating catalysts for improved denitrogenation. A goal was set of approximately 0.3 weight percent in the 390 to 850°F distillate fraction. A catalyst screening study utilizing six commercial catalysts showed that a Shell 324 nickel-molybdenum 1/32 inch extrudate was superior to two other nickel-molybdenum catalysts, two cobalt-molybdenum catalysts, and a nickel-tungsten catalyst. The Shell 324 catalyst was run for 33 days of continuous operation and demonstrated conversion levels of 55 to 65 volume percent 850°F+ (based on feed) with a distillate product (390 to 850°F) containing approximately 0.3 weight percent nitrogen and 32 to 128 ppM sulfur. Catalyst activity was maintained by small temperature adjustments. Proprietary LC-Fining expanded bed correlations for residuum processing of petroleum are applicable to coal liquids processing.

2412 (FE—2244-20) **Flash pyrolysis coal liquefaction process development. Annual report, January-December 1977.** Knell, E.W.; Duraiswamy, K.; Shaw, B.W.; Green, N.W.; Che, S.C. (Occidental Research Corp., Irvine, CA (USA)). 1978. Contract EX-76-C-01-2244. 92p. Dep. NTIS, PC A05/MF A01.

The Flash Pyrolysis Coal Liquefaction process development unit processed a caking bituminous coal for up to 22 hours continuously without plugging and thus established the technical feasibility of ORC caking coal reactor. Prior to the caking coal tests, we made three extended runs of one week duration and obtained baseline material balance data by pyrolyzing a subbituminous coal. Mass and elemental balance closures in the baseline runs were good. The extended operation of the PDU with the caking coal was hampered by unstable circulation of recycle char to the reactor. This was overcome by the development of a pneumatic char circulation technique using a fluidized-bed lift-tube char feeder. We developed a generalized data reduction routine for computer adjustment of data from the PDU and the BSR. We obtained kinetic parameters for the tar formation and cracking reactions based on the BSR data. The tar yields from subbituminous coal in the PDU baseline runs were found to be lower than those of the bench-scale reactor. The recycle char in the PDU was shown to be responsible for this. The addition of reactive carrier gases such as steam and carbon dioxide resulted in higher tar yields even in the presence of char. Apparently, these reactive gases retard the adsorption of tar vapors on the char surface. The processability of the PDU-derived tar in a continuous hydrotreater was demonstrated in a 40-hour test.

2413 (FE—2468-62) **ESCOE engineering program. Quarterly report, June 1, 1979-August 31, 1979.** Hill, R.F. (Engineering Societies Commission on Energy, Inc., Washington, DC (USA)). 14 Sep 1979. Contract EF-77-C-01-2468. 19p. Dep. NTIS, PC A02/MF A01.

The final report on Task 002, Coal Conversion Comparisons, and Task 014, Assessment of Oil Mining Development, were published during this reporting period. Reports and proceedings were published on two workshops, Advanced Industrial Technology and Fluid Dynamics and Thermal Processes. Other tasks are described briefly, and progress is reviewed.

2414 (FE—2566-25) **Upgrading of coal liquids. Interim report: hydrotreating and reforming Exxon Donor Solvent (EDS) Process derived naphthas.** Tan, G.; DeRosset, A.J. (UOP, Inc., Des Plaines, IL (USA). Corporate Research Center). Feb 1979. Contract EF-77-C-01-2566. 48p. Dep. NTIS, PC A03/MF A01.

Exxon Donor Solvent (EDS) Process naphtha has been processed in research pilot plants into 100 octane motor fuel by conventional refinery processes, using commercial UOP catalysts. The naphtha comprises principally cyclic hydrocarbons. In addition, it contains over 10% heterocyclic structures, such as phenols, pyridines, and thiophenes. Hydrotreatment was effective in reducing the sulfur and nitrogen to levels acceptable for reforming. Conditions used were substantially more severe than required to clean up a Middle East naphtha. However, they were well within commercial practice for hydrotreating heavier petroleum distillates. Reforming the hydrotreated naphtha gave 90 volume percent of 100 octane gasoline. Conditions were relatively mild due to the predominance of cyclic structures in the feed. Dehydrogenation of naphthenes to aromatics was the principal reaction. It yielded 1630 SCF/bbl hydrogen, about twice the amount needed for the preliminary hydrotreatment. Other naphthas, derived by hydrocracking EDS Process 400°F+ distillates, were also successfully reformed to high octane at high yields, plus hydrogen for use in upstream processing.

2415 (FE—2566-26) **Upgrading of coal liquids: upgrading distillates from coal liquefaction. Annual report, January 31, 1978-January 31, 1979.** deRosset, A.J.; Tan, G.; Hilfman, L. (UOP, Inc., Des Plaines, IL (USA). Corporate Research Center). May 1979. Contract EF-77-C-01-2566. 16p. Dep. NTIS, PC A02/MF A01.

Distillates from DOE-sponsored coal liquefaction products have been examined as potential feedstocks to commercial petroleum refining processes. The ultimate objective is to provide a new source of transportation fuels and environmentally acceptable fuel oils. Coal-derived naphthas from the H-Coal and Exxon Donor Solvent (EDS) processes have been hydrotreated and reformed in research pilot plants to 100 Research Octane Number (RON) gasoline. Conditions for hydrotreating were relatively severe compared to those required to treat a Middle East naphtha. Reforming proceeded at relatively mild conditions. Hydrogen yield was greatly in excess of the amount required for hydrotreating. The 400°F+ distillates from the H-Coal and EDS processes have been converted in research pilot plants by hydrotreating, hydrocracking and fluid catalytic cracking (FCC). In general, hydrotreatment is required prior to either hydrocracking or FCC to reduce excessive amounts of nitrogen and to enhance processability. Hydrotreating alone will give high yields of environmentally acceptable No. 2 fuel oil. Hydrocracking to gasoline proceeded at operating conditions somewhat more severe than required for a Middle East gas oil. Hydrogen consumption was high. However, a portion of the hydrogen can be recovered by reforming the hydrocracked naphtha to 100 RON gasoline. Additional hydrogen can potentially be recouped by steam reforming light gases. The hydrotreated distillates responded to fluid catalytic cracking as well as petroleum derived stocks of comparable hydrogen content. FCC gasoline product octane numbers ranged from 92 to 99 RON.

2416 (FE—4189-15) **Solvent refined lignite process development. Final technical report, June 16, 1977-June 15, 1978.** Severson, D.E. (North Dakota Univ., Grand Forks (USA). Engineering Experiment Station). 5 Jan 1979. Contract EF-77-C-02-4189. 96p. Dep. NTIS, PC A05/MF A01.

Throughout Project Lignite there were evolutionary changes in the process and in the process development unit (PDU). Objectives of the study included: (1) to determine if the process would be self-sufficient in production of process solvent; (2) to determine the most favorable gas recycle and gas make-up requirements; (3) to provide information necessary for economic evaluation of the SRL process; and (4) to provide design criteria for subsequent scaleup. The continuation of Project Lignite demonstrated the ability of the PDU to operate for extended periods. Three runs, each scheduled for 28 days of continuous operation, were completed. The effects of solvent recycle and off-gas cleaning and recycling were determined. Several runs using feed coal from different sources were made. Accumulation of solids in the reactor remained an unresolved problem in maintaining long-term operation of the PDU. Unreacted lignitic materials together with the ash evidently agglomerated and were not removed with the slurry and gas. Metallurgical studies to determine the effects of the reactor environment on various materials of construction were conducted. Prestressed coupons of seven different metals were placed in the reactor. Only carbon steel showed any significant general attack, and there was no evidence of transgranular or intergranular corrosion in any of the specimens.

2417 (SAND—79-1969) **Catalyst characterization in coal liquefaction. Third quarterly report, April 1-June 30, 1979.** Thomas, M.G. (Sandia Labs., Albuquerque, NM (USA)). Oct 1979. Contract EY-76-C-04-0789. 18p. Dep. NTIS, PC A02/MF A01.

A charge of neutron activated American Cyanamid 1442A CoMo catalyst with total activity of Co^{60} of ~ 390 μCi has been prepared for use in the H-Coal Process Demonstration Unit. Catalysts tested by HRI in (1) a fixed bed with low ash feedstock and (2) an ebullated bed and fixed bed with higher-ash containing feedstocks corroborate other evidence that the regions of high reflectivity near used catalyst surfaces are due to the pressure of containment mineral matter, primarily iron and titanium. Parametric experiments with coal, preasphaltene, asphaltene, and oil, in tubing reactors, show that production of hydrocarbon gases increases in the series oil < asphaltene < preasphaltene, that both a CoMo catalyst and pyrite addition lowers the production of C_1-C_4 hydrocarbons, and that pyrite significantly increases the amount of CO and CO_2 generated.

2418 **Selectivity improvement in the SRC process.** Garg, D.; Tarrer, A.R.; Guin, J.A.; Lee, J.M.; Curtis, C.W. (Auburn Univ., AL). *Fuel Process. Technol.;* 2: No. 3, 189-208(Jul 1979).

The selectivity for hydrodesulfurization over hydrogenation has been examined in a new short residence time catalytic two-stage SRC process, which has the potential of producing a low-sulfur solid SRC product to meet the newly proposed EPA new point source emission standards (NPSES). In the first stage of the process, residence time and hydrogen consumption are minimized through the use of an inexpensive mineral catalyst (SRC residue ash) that has been treated under a combustion environment to improve its selectivity for hydrodesulfurization over hydrogenation. The second stage of the process involves hydrotreating the filtered liquid product with a commercial Co-Mo-Al catalyst, before splitting into a solid SRC and solvent recycle by distillaton. Several process varia-

bles - such as type of coal, catalyst, temperature, hydrogen partial pressure, and reaction time - have been examined to provide information on hydrogen consumption, product distribution, sulfur removal, SRC yield and solvent quality. The results show that the ash of SRC residue can be used to selectively catalyze desulfurization over hydrogenation in SRC processing. Selectivity for desulfurizaton in two stage hydrodesulfurization of coal is improved by using high reaction temperatures, short residence times, the ash of SRC residue as a first stage catalyst, and Co-Mo-Al as a second stage catalyst. Two stage catalytic SRC processing is more selective for hydrodesulfurization than catalytic or non-catalytic single stage SRC processing. 11 figures, 9 tables.

2419 Mixer assures consistent feed to synthetic fuel reactor. Powdered coal/solvent slurry is readied in seconds. Heher, B. (Univ. of North Dakota, Grand Forks); Gaines, A. *Chem. Process. (Chicago);* **41**: No. 5, 118-119(Apr 1978).

Poor liquids/solids mixing was hampering the development of a process for the production of low-sulfur solvent-refined lignite, by liquefaction of lignite in a high pressure reactor. The lignite used consists of small particles which are blended with a petroleum-based, highly aromatic solvent. The solid/liquid ratio is approximately one part coal to 1.5 to 2 parts of solvent, and the reactor feed system is designed for continuous feed rate of ca 3 lb/m. The improved mixing system is a horizontal, continuous mixer which features 2-forward and 1-reverse angle paddle blades in each mixing section. The curved and canted overlapping blades gently lift and tumble the materials in a figure 8 pattern which will thoroughly mix solids of widely varying density. Even with a residence time of only 10 to 15 s in the mixer, problems associated with poorly wetted lignite powder, agglomerates and wide variations in density and viscosity have been eliminated. 2 figures.

PYROLYSIS AND CRACKING

REFER ALSO TO CITATION(S) 2404

2420 Flash hydropyrolysis of coal. Steinberg, M.; Fallon, P. (Brookhaven Natl Lab, Upton, Ny). *Chem. Eng. Prog.;* **75**: No. 6, 63-66(Jun 1979).

Following early work in the 1960s on the rapid gas-phase hydrogenation of coal for the synthesis of liquid hydrocarbons, preliminary bench-scale experiments in a 19-mm diameter * 2.4-m long downflow reactor was undertaken at Brookhaven National Laboratory in 1974. When hydrogenating lignite at temperatures and pressures up to 700;degree;C and 1,500 psi (10,343 kPa), the results indicated significant yields of liquids, especially benzene, and gaseous hydrocarbons, particularly methane and ethane. The liquid yields increased for reaction residence times less than 30 seconds. Preliminary process design and economic evaluation of a flash hydropyrolysis process indicated a reasonable return on capital investment. In late 1976, a larger, versatile, and highly instrumented, entrained downflow tubular reactor was constructed and placed into operation. Experimental apparatus is described and results of the operation are given. Process design and preliminary economic estimates were made for three versions of the FHP process system: 1) producing only liquid products for motor gasoline fuel; 2) producing both liquid and gaseous hydrocarbon products for motor gasoline and pipeline gas; and 3) producing only gaseous products for pipeline gas.

PROPERTIES

REFER ALSO TO CITATION(S) 2385, 2406, 2453

2421 (CONF-781186—3) Effect of ultrasound on liquid flow through porous materials. Fairbanks, H.V. (West Virginia Univ., Morgantown (USA). Coal Research Bureau). 1978. 9p. West Virginia University, Morgantown, WV.

From 96. meeting of the Acoustical Society of America; Honolulu, HI, USA (27 Nov 1978).

The results of three research investigations are reported. They include: (1) ultrasonic assist in vacuum filtration of powdered materials, (2) ultrasonic stimulation of crude oil flow through porous sandstone, and (3) ultrasonic assist in drying powdered materials. For each of these processes it was found that in the conditions described, the introduction of ultrasound could substantially improve the liquid flow rate. An ultrasonic frequency of 20kHz was used with up to 500 watts of total power input.

2422 (DOE/EV—0046(Vol.1), pp 428-440) Analytical study of the effluents from a high temperature entrained flow gasifier. Hansen, L.D.; Phillips, L.R.; Ahlgren, R.B.; Mangelson, N.F.; Eatough, D.J.; Lee, M.L. (Brigham Young Univ., Provo, UT). Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

Effluent streams from a 100 pound per hour, pressurized, high temperature, entrained flow coal gasifier have been found to be extremely clean compared to those of other gasifiers. The water-scrubbed gaseous effluent contained only CO, H_2, CO_2, N_2, CH_4, and traces of H_2S and HCN. The gas obtained by depressurization of the scrubber water contained trace amounts of SO_2 in addition to these other seven gases. Polycyclic aromatic hydrocarbons, the only non-volatile organic compounds found in the scrubber water, were completely absorbed on the particulate matter. Most of the H_2S produced in the gasifier became oxidized to elemental sulfur and also appeared in the scrubber water in the particulate matter. The concentrations of elemental and inorganic species were found to be below the level of environmental concerns. Statistical analysis was used to determine the effects of the process parameters: coal type, coal feed rate, reactor pressure, oxygen to coal ratio, and steam to coal ratio. Sufficient environmental control can be achieved by removing the H_2S from the gaseous effluent using an appropriate commercial process and by separating the particulate matter from the scrubber water. Particulate matter separation methods include flocculation settling, froth flotation and filtration. Flocculation is probably the most economical of these separation methods. Laboratory bench scale separation tests and mass balance calculations should provide valuable information as to which environmental control technology is most economically feasible.

2423 (FE—2696-T1) Development and application of analytical techniques to chemistry of donor solvent liquefaction. Quarterly progress report, September-November 1978. Squires, A.M.; Dorn, H.C.; Taylor, L.T.; Dillard, J.G.; Rony, P.R. (Virginia Polytechnic Inst. and State Univ., Blacksburg (USA)). Mar 1979. Contract EF-77-G-01-2696. 34p. Dep. NTIS, PC A03/MF A01.

Major effort has concentrated upon the ^{19}F nmr analytical approach for characterization of functional groups in model compounds and in coaly matter. Progress in this effort is reported. Additional work is also in hand on high temperature ^{13}C nuclear magnetic resonance spectroscopy of melts of coaly matter and on separation studies in a variety of solvents of model compounds via Gel Permeation Chromatography.

2424 (FE—2696-T2) Development and application of analytical techniques to chemistry of donor solvent liquefaction. Quarterly progress report, June-August 1978. Squires, A.M.; Dorn, H.C.; Taylor, L.T.; Dillard, J.G.; Rony, P.R. (Virginia Polytechnic Inst. and State Univ., Blacksburg (USA)). Nov 1978. Contract EF-77-G-01-2696. 25p. Dep. NTIS, PC A02/MF A01.

Efforts have been concentrated on measuring the mass spectra of selected fractions of THF soluble Amax SRC. The fractions examined were obtained from the neutral and base separation scheme described in earlier progress reports. For selected milliliter fractions positive ion mass spectra were measured at low electron energies (15 ev) to enhance molecular ion formation. The spectra were measured as a function of temperature so that components with a range of vapor pressures could be examined. For chromatographed fractions of either neutral and base separated components, differences in the mass spectra at a given temperature and the variation in the mass spectra with temperature programming were noted. The mass spectral results indicate that separation of the various components in SRC is enhanced by the acid-neutral-base separation scheme, but that within the neutral and base fractions, many distinct molecular species are present. Unimolecular decomposition processes associated with the fragmentation of methyl substituted components have been identified.

2425 (NP—24068) Pollen analyses in the Rhenish main brown coal seam of the Frechen and Fortuna open cast mines with special regard to coal macropetrography. Hiltmann, W. (Technische Hochschule Aachen (Germany, F.R.). Fakultaet fuer Bergbau und Huettenwesen). 26 Nov 1976. 181p. (In German). Dep. NTIS (US Sales Only), PC A09/MF A01.

Pollen analyses were carried out in two seam profiles of te Frechen open-cast mine and two seam sections of the Fortuna open cast mine of Rhenish brown coal in continuous series of samples. The analyses were based on macropetrographic pictures of the seam. The dissertation attempts a palynological characterization of lithotypes, i.e., coal elements that can be distinguished by macropetrography and thus an interpretation of these elements in the sense of botanical-ecological facies types of the brown coal moor.

2426 Coal chemistry. 8. Reactions of tetralin with coal and with some carbon-14-containing model compounds. Collins, C.J.; Raaen, V.F.; Benjamin, B.M.; Maupin, P.H.; Roark, W.H. (Oak Ridge National Lab., TN). *J. Am. Chem. Soc.;* **101**: No. 17, 5009-5014(15 Aug 1979).

When coal was treated with tetralin-l-^{14}C at 400°C, small yields of α- and β-methylnaphthalenes-^{14}C were observed. In order to determine the mechanism of the reaction, tetralin was heated with ^{14}C-labeled 1,3-diphenylpropanes (1), with 1,3-diphenylpropene (2), and with ^{14}C-labeled phenetoles (3). In each case methylnaphthalenes were observed, and the origins of the methyl groups were

determined with carbon-14. In addition to the methylnaphthalenes, 1 and 2 also yielded toluene and ethylbenzene (after 19 h), whereas phenetole-β-^{14}C (3-β-^{14}C) yielded toluene (unlabeled) plus ethyl-^{14}C-benzene, benzene, phenol, and a mixture of α- and β-ethyl-^{14}C-naphthalenes. Crossover experiments with labeled phenetole and unlabeled ethyl p-tolyl ether proved the intramolecularity of the reaction phenetole → toluene + ethylbenzene, thus illustrating a 1,2-phenyl shift from oxygen to carbon.

2427 **^{13}C, ^{2}H, ^{1}H NMR and GPC study of structural evolution of a subbituminous coal during treatment with tetralin at 427°C.** Franz, J.A. (Battelle Mem Inst, Pac Northwest Lab, Richland, Wash). *Fuel;* **58**: No. 6, 405-412(Jun 1979).

The products from the thermal dissolution of subbituminous Kaiparowitz coal at 427°C are examined by spectroscopic (^{13}C, ^{1}H, ^{2}H n.m.r., i.r.) molecular weight (gel-permeation chromatography and vapor pressure osmometry) and elemental analysis, and hydroxyl group analysis. The use of 1,1-dideuterotetralin in conjunction with ^{2}H n.m.r. to monitor the time dependence of introduction of deuterium into aliphatic and aromatic structures is presented. The tetralin-derived products were monitored versus time.

2428 (FE—2676-1) **Analytical studies for the H-Coal process.** Becker, M.; Bendoraitis, J.G.; Bloch, M.G.; Cabal, A.V.; Callen, R.B.; Green, L.A.; Simpson, C.A. (Mobil Research and Development Corp., Paulsboro, NJ (USA)). [nd]. Contract EF-77-C-01-2676. 39p. Dep. NTIS, PC A03/MF A01.

H-Coal Syncrude product streams, prepared from Illinois No. 6 coal, have been obtained from the Trenton, N.J., Process Development Unit of Hydrocarbon Research, Inc., and characterized by a combination of anlytical techniques. In addition to basic physical properties, the elemental compositions, trace metal levels, and molecular composition data have been determined. The trace metal levels are generally low, but a relatively high metal level was observed for the heavy fuel oil. Detailed analyses of molecular species indicate that, although these streams bear some similarities to petroleum streams of comparable boiling range, there are some important differences. For examples, the non-aromatic cuts from these coal liquids are more naphthenic, and the aromatic cuts account for a higher proportion of the streams. Also, coal liquids contain significant amounts of highly polar compounds, principally oxygenates and nitrogen containing compounds. The H-Coal naphtha has a high oxygen content due to the presence of phenols and a high basic nitrogen content due to the presence of anilines and pyridines. These nitrogen and oxygen compounds would need to be removed by processes such as hydrotreating prior to use as gasoline. Composition studies further show that the naphtha contains predominantly cyclic compounds, which upon catalytic reforming should yield high octane gasoline and hydrogen, primarily due to dehydrogenation of these naphthenes.

WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 2384, 2386, 2387, 2433, 2938, 2940, 2941, 2942

2429 (ANL/WR—79-1) **Removal of organic constituents in a coal gasification process wastewater by activated sludge treatment.** Stamoudis, V.C.; Luthy, R.G.; Harrison, W. (Argonne National Lab., IL (USA)). Jun 1979. Contract W-31-109-ENG-38. 47p. Dep. NTIS, PC A03/MF A01.

The wastewater sample was obtained from a pilot-scale HYGAS run. Wastewater was pretreated to reduce ammonia and alkalinity and was then processed in an activated sludge reactor at a hydraulic residence time of two days with a bacterial mean cell residence time of 15 days and a COD removal rate of 0.86 per day. Analysis indicates that activated sludge treatment removed the bulk of the extractable and chromatographable organic constituents. The influent acidic fraction, composed mainly of phenol and alkylated phenols, constituted 98.5% of the total organics identified; these were removed almost completely. Organics of the basic fraction, composed mainly of alkylated pyridines and anilines, were removed effectively, with the exception of certain alkylated pyridines. In the case of the organics in the neutral fraction, which constituted less than 0.75% of the total organics in the influent, certain heterocyclics and compounds containing heteroatoms were removed effectively. For aromatic hydrocarbons, the more aliphatic the substitution or alicyclic the content, the less the removal. Alicyclic hydrocarbons and alkylated benzenes generally were removed poorly or very poorly. 9 figures, 7 tables.

2430 (DOE/FE/2549—33) **Development of potential uses for the residue from fluidized-bed combustion processes. Quarterly technical progress report, June-August 1979.** Minnick, L.J. (Department of Energy, Washington, DC (USA). Div. of Fossil Fuel Utilization). Oct 1979. Contract EF-77-C-01-2549. 25p. Dep. NTIS, PC A02/MF A01.

An AFB fly ash sample from Georgetown University shows a significant difference in visual appearance to that of other AFB fly ash sources. Differences in the chemical composition of spent bed residue samples from Rivesville, West Virginia, are probably attributable to variations in the calcium to sulfur ratio in the fluidized-bed during combustion. Comparison of the particle size distribution of spent bed samples from Alliance, Ohio, and Georgetown University reveals a close similarity in the basic sizing of these materials, with each being considered in the medium to coarse sand size range. Visual inspection of the separated overflow sample from mineral cyclone separation indicates that this product may contain a relatively high percentage of lime. On the basis of available data, it appears that detrimental volume expansion in road base compositions containing AFB residue can be reduced to a tolerable level by pretreatment, such as grinding and/or maximum hydration prior to use. Additions of relatively low percentages of AFB residue to acid mine waste-water resulted in significant increases in the percentage of solids of vacuum filtered samples, due to the low solids content of the wastewater sample. The addition of AFB residue to acid mine wastewater is effective in neutralizing the pH and dewatering the waste, although previous neutralization tests have shown that milled AFB residue is generally more reactive and effective than as received AFB residue. Combinations of equal weights of AFB residue and fly ash appear to produce relatively high strength block. Blocks with 80 percent AFB residue and 20 percent fly ash exhibited somewhat lower strengths with little or no cracking.

2431 (FE—2408-8) **Study of the mechanism of the hydrogen sulfide/dolomite reaction. Annual report, July 1977-June 1978.** Li, K.; Rogan, F.H.; Yen, J.H.; Huang, C.S. (Carnegie-Mellon Univ., Pittsburgh, PA (USA). Dept. of Chemical Engineering). Jul 1978. Contract EX-76-C-01-2408. 52p. Dep. NTIS, PC A04/MF A01.

Significant progress has been made in kinetic modelling for the calcination and sulfidation reaction. The rate and structure data obtained for the calcination of both Guelph and Stockbridge dolomites are consistent with the assumption that half-calcination is a pearlite reaction. While a detailed mathematical model for the sulfidation reaction is not yet fully developed, rate data are consistent with the assumption that, above 780°C and in the absence of CO_2, the sulfidation reaction occurs in two steps: decomposition of the $CaCO_3$, followed by sulfidation of the resulting CaO. No evidence has as yet been found for such a sequential mechanism in sulfidation of dolomite below 780°C. A limited amount of rate and structure data on the carbonation reaction has indicated that the reaction proceeds topochemically on the pellet level. Conversions as high as 80% have been achieved with completely sulfided dolomite.

2432 (FE—2652-T2) **Prototype anthracite culm combustion boiler/heater unit, City of Wilkes-Barre, Pennsylvania. Quarterly technical report No. 2, January 1-March 31, 1979.** (Wilkes-Barre, City of, PA (USA); Pope, Evans and Robbins, Inc., New York (USA); Foster Wheeler Corp., Livingston, NJ (USA)). 1979. Contract ET-78-C-01-2652. 49p. Dep. NTIS, PC A03/MF A01.

There are currently about 910 million cubic yards of anthracite culm (mine refuse) contained in 800 separate banks in a 480 square mile area in the Wilkes-Barre (W-B) anthracite mining region. Although this material represents a significant fuel value equivalent to approximately 1.25 billion barrels of fuel oil, the culm banks have been allowed to accumulate because no satisfactory method of combusting this fuel was available until the relatively recent development of the atmospheric fluidized bed (AFB) steam generator. A program was initiated in October 1978 to design, construct, and evaluate a 100,000 pph AFB steam generator burning anthracite culm with the addition of fresh anthracite if required and demonstrate it to be technically, economically, and environmentally feasible to produce 150 psig saturated steam for district heating in downtown W-B. Phase I of the program consists of the design of the Atmospheric Fluidized Bed (AFB) boiler and boiler plant and a hot model test program consisting of twenty-one 12-hour batch tests and one 100-hour continuous test to provide a preliminary assessment of anthracite culm as a fuel and to identify commercially acceptable operating conditions for the design of the AFB boiler plant. Phase II of the program consists of construction, operation, testing, and evaluation of the boiler and boiler plant.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 2385, 2387, 2388, 2422, 3191, 3579, 3580

2433 (DOE/EV—0046(Vol.1), pp 95-109) **Environmental control technology survey of selected US strip mining sites.** Johnson, D.O.; Bogner, J.E. (Argonne National Lab., IL). Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

This report summarizes the techniques and reagents used to control and treat mine drainage at 20 surface coal mines in the eastern and central US. Mine operations range from small contour mines to mountaintop removal operations to large area mines. Of the 20 mines surveyed, 10 are or have used chemical reagents to neutralize acid mine drainage. In the remainder, effluent pH generally falls within the US EPA limits of 6 to 9, and settling ponds are utilized only to promote flocculation of suspended solids and precipitation of dissolved solids. Where data could be compiled, the effectiveness, problems, and costs of alternative reagents are compared and contrasted. Further trends in mine drainage control technology for surface coal mines are explored in light of anticipated expansions in surface coal mining and recently promulgated EPA effluent guidelines. Major conclusions are: Mine drainage control and treatment at surface coal mines may not reflect conscientious planning and engineering design work by mine operators; surface mine operations favor small, efficient, and above all, portable application systems for neutralization reagents. When choosing a reagent to neutralize mine drainage, reagent cost per unit quantity is less of a deciding factor to surface coal mine operators than cost of reagent applications and handling. There needs to be more effort on the part of surface mine operators for pre-mining planning to minimize pyrite oxidation and hydration.

2434 (DOE/EV—0046(Vol.1), pp 393-408) **Preliminary environmental results of the LETC Hanna III underground coal gasification experiment.** Virgona, J.E.; Bartke, T.C.; Boysen, J.E.; Spedding, T.J.; Gardner, G.W. (Dept. of Energy, Laramie, WY). Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

Changes in ground-water quality and the possible effects of subsidence and ground movement induced by the underground gasification cavity represent significant environmental concerns associated with underground coal gasification (UCG). Parallel environmental studies are being conducted by the Laramie Energy Technology Center (LETC) and the Lawrence Livermore Laboratory (LLL) near Hanna and Gillette, Wyoming, respectively, to characterize these environmental effects and to develop the controls necessary to meet state and Federal environmental regulations and to insure environmentally sound commercialization. Ground-water studies are in the characterization phase, with control technology development to follow once the type and quantity of potential ground-water contaminants and overburden effects are determined. The paper discusses the LETC Hanna III environmental studies. The Hanna III experiment (June-July, 1977) was designed primarily to provide information on the potential impacts of UCG on groundwater quality and the environmental control technology implications of those impacts. In addition, parameters critical to the process itself were examined. Preliminary results of the ground-water monitoring during the pre-operational, operational, and early portion of the post-operational phases will be presented.

2435 (DOE/EV—0046(Vol.2), pp 453-463) **Environmental concerns influencing the future development of energy material transportation systems: the year 2000 study.** DeSteese, J.G. (Battelle Pacific Northwest Labs., Richland, WA). Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

Results of studies conducted for the Department of Energy by Pacific Northwest Laboratory to assess the potentially longer-range problems which could hinder the future development of safe and environmentally acceptable energy material transportation systems are presented. The purpose of this effort is to recommend appropriate actions that contribute to the anticipatory management of possible future problems before they can have serious effects on the adequacy or acceptability of the system. Most significant future concerns in energy material transportation relate to potential institutional, legal, political, and social problems. Environmental issues are involved in many of these concerns. Selected environmental concerns are discussed that may influence the future development of transportation systems for nuclear and fossil energy materials during the balance of this century. A distinction between potentially real and perceived concerns is made to emphasize basic differences in the recommended approach to solutions of the respective type of potential problem.

2436 (SRC—7017-3) **Environmental implications of lignite development. Final report.** Limaye, D.R. (Synergic Resources Corp., Bala-Cynwyd, PA (USA)). Apr 1979. 19p. Dep. NTIS, PC A02/MF A01.

This working paper summarizes the major environmental implications of lignite development in Arkansas and Louisiana. Most of the potential impacts relate to the surface mining operation and include: water resource impacts, erosion/sedimentation, land use, fugitive dust, ecological effects, historic and archaeological resources, and related effects. This working paper was prepared in support of the development of the Lignite Research Agenda for the Ozarks Regional Commission. Funds were provided by the US Department of Energy, Region VI Office. During the development of the Agenda, Synergic Resources Corporation personnel worked in close cooperation with and under the supervision of the Lignite Steering Committee. Members of this Steering Committee included representatives of the local economic development districts, the two state energy offices, state geological surveys and Commission staff.

RESERVES AND EXPLORATION

2437 (INKA-Conf—78-210-001) **Contribution of the mine surveyor to raw materials supply, illustrated by the examples of deposit detection and rock damage prevention.** Kratzsch, H. (Ruhrkohle A.G., Essen (Germany, F.R.)). 1978. 17p. (In German). (CONF-7809149—1). Dep. NTIS (US Sales Only), PC A02/MF A01.

From Geodesy and existence planning conference; Berlin, F.R. Germany (20 Sep 1978).

An EDP information system on coal deposits is described. The digital model requires a data bank for all deposits characteristics collected, classified according to certain aspects such as tectonics, stratigraphy, and mine buildings. Apart from the fixing of the underground mine field borders, prevention of rock damage is discussed as another task of the mine surveyor.

2438 (SRC—7017-1) **Ozarks Regional Commission Lignite Research Agenda. Final report.** (Synergic Resources Corp., Bala-Cynwyd, PA (USA)). May 1979. 113p. Dep. NTIS, PC A06/MF A01.

The Ozarks Regional Commission (ORC), following up on the recommendations of its Regional Energy Alternatives Study, conducted a Lignite Conference in May 1978 to bring together knowledgeable and interested parties to discuss the opportunities and constraints for lignite development. This conference focused public attention on the potential benefits and impacts of lignite development in Arkansas and Louisiana, and identified the need for additional information regarding the lignite resource base, characteristics, utilization potential and developmental impacts. ORC therefore commissioned this study to generate a Lignite Research Agenda. The principal objective of this project was to develop a Lignite Research Agenda to be undertaken by the public sector to establish a concerted regional effort of balanced and orderly development of the lignite resources in Arkansas and Louisiana. The research agenda addresses the following areas: Lignite resource base, technologies for conversion/utilization, market potential for lignite, environmental impacts of lignite, socio-economic impacts of lignite, regulatory and institutional factors, and information dissemination. The summarized research agenda includes a definition of: Prioritization of research areas, research objectives and potential benefits, definition of research programs, identification of specific projects, schedule, funding requirements, and co-funding possibilities and relationship to other existing research programs.

2439 **Bibliography of Wyoming coal.** Glass, G.B.; Jones, R.W. Laramie, WY; Geological Survey of Wyoming (1974). 164p. (NP—24150). Geological Survey of Wyoming, PO. Box 3008, University Station, Laramie, WY 82071.

This bibliography contains not only geological references to Wyoming coals but also non-geologic references to Wyoming's coal mines, coal mining industry, and coal utilization. It includes 1223 references published through approximately July 1973. Authors are arranged alphabetically, and the papers with full title and medium of publication are listed chronologically under the author's name. An exhaustive index includes subject, stratigraphic, and locality divisions. Localities are generally broken down into the ten major coal-bearing regions; in a few cases, they are taken down to individual coalfields.

MINING

REFER ALSO TO CITATION(S) 2433

2440 (ALO—0789-T11) **Investigation of water jet drilling for methane drainage. Technical progress report, FY 1979.** Timmerman, K.M. (Sandia Labs., Albuquerque, NM (USA)). 1979. Contract EY-76-C-04-0789. 22p. Dep. NTIS, PC A02/MF A01.

The Drilling Technology Division of Sandia Laboratories is developing a water jet drilling system which can be used to drill holes for draining methane from coal beds or for linking coal gasification wells. Funding is supplied by the Morgantown Energy Technology Center. The system will be designed to drill horizontally from existing vertical boreholes for distances up to 1000 feet at seam depths of 1000 feet or less. The two areas of new technology involved are cutting a competent hole in coal with high pressure water jets and passing an articulated Drill String around the sharp corner between the vertical and horizontal holes. The University of Missouri-Rolla, under contract to Sandia, is working on improvements to the Drilling Head which they developed in an earlier

project. Sandia, with UM-R assistance, has designed a prototype round-the-corner mechanism. A scale model of it is being built for use in concept evaluation. Major problem areas at this point include factors limiting length of pentration, bore gage control and seam boundary detection.

2441 (FE—9010-T1) **Rock mechanics study of shortwall mining. Final technical report, 30 April 1979.** Wright, F.D.; Howell, R.C.; Dearinger, J.A. (Kentucky Univ., Lexington (USA)). Apr 1979. Contract ET-73-C-01-9010. 288p. Dep. NTIS, PC A13/MF A01.

This report describes a rock mechanics study performed in conjunction with a demonstration of the shortwall mining method at the Bethlehem Mining Corporation Hendrix Mine No. 22. There were three general areas of investigation: (1) determination of geologic structure and physical properties of the rocks; (2) measurement of rock stresses, including horizontal as well as vertical rock stresses; and (3) measurement of ground movement including surface and subsurface movements. In addition, response tests were performed on flat borehole pressure cells (BPC's) and on vibrating wire stressmeters which were used to determine changes in rock stress. In situ rock stresses were measured by the borehole deformation method. Ground movement was monitored by measurements of convergence, floor heave, and differential roof sag in development openings; by surface subsidence measurements; and by measurement of subsurface subsidence with multiple position borehole extensometers placed in boreholes drilled from the surface. Observations and conclusions were as follows: (1)the roof rocks, as well as the floor rocks, were very competent; (2) there was very good correspondence between beam theory and cracked-beam theory with the observed failure of the main and immediate roofs; (3) the main shale roof caved 90 feet up to the bottom of a thick, competent, sandstone bed, which deflected but did not cave; (4) the chain pillars between panels crushed during the mining of the third panel, and this factor, plus the presence of the overlying sandstone bed, resulted in a flat-bottomed, subsidence trough on the surface, which did not reflect the presence of the underlying chain pillars; and (5) the failed chain pillars acted as efficient strip packs, which limited subsidence to less than 45 percent of the coal thickness and took most of the overburden load.

2442 (NP—24146, pp 10-39) **Fundamentals and safety.** 1977. (In German).

In Steinkohlenbergbauverein annual report 1977.

Research and development activities of the Steinkohlenbergbauverein in the fields of mine ventilation, dust prevention, explosion prevention, and mine surveying are presented. Also discussed are mine rescue, guidelines, and mine safety.

2443 (NP—24146, pp 40-79) **Mining.** 1977. (In German).

In Steinkohlenbergbauverein annual report 1977.

The mining technology section deals with R & D activities of the Steinkohlenbergbauverein in the fields of planning and operation control, roadway drivage, rock control, winning, driving, transport, and supply techniques.

2444 Combined method of controlling travelling dust in the drift. Fes'kov, M.I. *Ugol;* No. 10, 22-24(Oct 1978). (In Russian).

A description is given of an experiment undertaken to establish the rational parameters of isolating and irrigating dust formation centers that provide for maximum dust suppression. A description is given of the experimental apparatus, a formula is derived for finding the isolation coefficient (in %) as a function of the maximum amount of air passing through a tube at a velocity of 1 m/s and the reduced amount of air corresponding to the exchange of air when a cover is present. Experimental relationships are given between the effect of the isolation coefficient on the effectiveness of dust precipitation by irrigation, the relationship between the residual dust and the specific flow rate of water with the use of various irrigators, and the relationship between the volumetric ejection coefficient and the water pressure in front of the force pump. The proposed combined method of dust control, comprising isolation and external irrigation, was found to provide for distinct improved working conditions at a smaller expenditure of water. 4 figures, 2 tables.

2445 Control of coal dust and the gassing of working faces in direct flow ventilation. Zharov, A.I. *Ugol;* No. 10, 24-26(Oct 1978). (In Russian).

Field studies were made of combining longwall mining with direct flow ventilation in six mines for the purpose of determining the distribution of methane and dust concentration in an air stream along the wall and conveyer drift in the Inskii-1 coal seam. Illustrations are offered of the position of measurement points and the seam mines, and the distribution of air, methane and dust concentration is indicated for a longwall and for a conveyer drift behind the longwall. The proposed method was shown to reduce the average amount of dust in the drifts by 1.6 times. An analysis of the results indicated that further significant reduction in dust amounts requires additional study on the feeding adhesive components that retain their properties over a prolonged period of time. 3 figures.

2446 Relationship between drift stability and the method by which it is tunnelled. Anosov, A.S.; Korshukov, V.N.; Krivtsov, I.I. *Ugol;* No. 10, 26-27(Oct 1978). (In Russian).

Instrumental observations were made of rock displacement in the cross-section of a drift cut drill-blasting and the Yasinovatets combine over a five year period in the ground of a field group drift of a seam on 860 meter hill in order to establish the relationship between stability and the method of cutting a mine area. Mathematical processing of test data on the Minsk-32 computer yielded curves describing the cross-sectional and time-related rock shift processes in a drift cross section perpendicular to the rock stratification. The experiment and results of instrumental observations indicated that the combines can increase the stability of mine workings, the mechanization of preliminary operations, and broaden the region of the pillar mining system as well as increase work safety. The use of the entry-driving machines is recommended for mines in the central region of the Donets Basin. 3 figures.

2447 Use of coal and rock cleavage in working faces. Lykov, I.F. *Ugol;* No. 10, 31-33(Oct 1978). (In Russian).

A discussion is made of the importance of the cleavage of coal seams as a general criterion for selecting systems of mining, roof control, seam degassing, changing water flow direction, and other technological processes. Recommendations are made for surveying cleavage systems in coal seams and roof rock for superimposing on coal operation plans. 2 figures.

2448 Effect of a coal seam's temperature on the readings of hydraulic sensors. Gaiko, E.I.; Gorbunov, A.K.; Kantsan, P.M. *Ugol;* No. 10, 40-42(Oct 1978). (In Russian).

Tests were made of well hydraulic sensors under laboratory and actual conditions in order to simulate approximately the behavior of sensors measuring stress states of rock in reference pressure zones in vibration-prone seams of the central region of the Donets Basin at depths of 650 to 850 meters. Pressure and temperature changes were recorded for various distances between the sensor and the face for different seams, and stress-state diagrams were compiled from the sensor data. The experimental results indicate that the presently used sensors must be equipped with compensatory units to account for changes in environmental temperature. The use of data on stress states recorded by hydraulic sensors without automatic adjustment devices is not recommended. 3 figures, 2 tables.

2449 Characteristics of cleaving dislocations and methods of studying them. Kramarenko, A.I. *Ugol;* No. 10, 55-56(Oct 1978). (In Russian).

A geological tabulation and statistical structural tectonic analysis were made of 18 cleaving dislocations exposed by underground workings of a group of mines in the Donetsk-Makeev region of the Donets Basin in order to identify the characteristics of the cleavage zones and to establish the tectonic conditions of both adjacent and remote zones. Relationships were obtained between changes in the fissure intensity of roof rock in fold limbs and the distance to the displacer, and between fissure intensity changes of roof rock in limbs of a fault and the distance to the displacer. The data indicate that the basic signs of cleavage zones are the elevated density fissure sections of coal seam and surroundings accompanied by unstable roof zones that are prone to caving and gas blow-outs. 4 references, 3 figures.

2450 Some recent developments in percussive rock drilling for mining, quarrying, and tunnelling. Hodge, J. (Holman Brothers Ltd., Camborne, England). pp 19-27 of Fluid power equipment in mining, quarrying, and tunnelling. London, England; Institution of Mechanical Engineers (1974).

From Conference on fluid power equipment in mining quarrying and tunnelling; London, UK (12 Feb 1974).

The development of rigs for mounting rock drills is sketched, with particular emphasis on the trend towards an increasing degree of automatic operation of as many functions as possible. Percussive drilling machines are also discussed; up to the present time they have been almost exclusively pneumatically powered, but there is increasing interest in the potential of hydraulic operation. A new method of rock extraction being developed for reef mining in South Africa is described.

TRANSPORT AND HANDLING

REFER ALSO TO CITATION(S) 2375, 2395, 3191, 3512

2451 (DOE/EV—0046(Vol.1), pp 110-127) **Development of coatings for protection of coal during transport and storage.** Kromrey, R.V.; Naismith, R.; Scheffee, R.S.; Valentine, R.S. (Atlantic Research Corp., Alexandria, VA). Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

The use of coatings to prevent dust emissions and leachates from coal stockpiles was studied under sponsorship of the Depart-

ment of Energy, Division of Environmental Control Technology, under contract EP-78-C-02-4632. The coatings considered included compositions formed of a filler such as pulverized coal and a binder consisting of a combination of waxes and plastics. Various latex emulsions, both with and without fillers, were also evaluated. The purpose of coal coatings is to seal the surface of the stockpile. This prevents water penetration into the coal. By sealing the surface of the pile, dust losses are prevented and leachate formation is minimized. Air circulation through the stockpile is also greatly reduced. This yields the added benefits of reduced oxidation of the coal and prevention of spontaneous ignition. Cold weather handling characteristics of the coal are also improved. Physical properties of the coatings were measured. Included were such characteristics as resistance to water penetration and degradation as a result of thermal cycling. Application techniques were also evaluated. Both hot-applied and cold-applied coatings were considered. Protective coatings appear to be an attractive means of prevention of fugitive emissions from coal stockpiles. The economic benefits from reduced oxidation and improved handling more than offset the cost of application. Use of coatings on unit trains may also be attractive.

2452 (FE—2475-26) **Developing/modifying coal grinding procedures and equipment to produce predictable size distributions during coal preparation. Annual progress report, October 1977-December 1978.** Luckie, P.T. (Kennedy Van Saun Corp., Danville, PA (USA)). 15 Jan 1979. Contract EX-76-C-01-2475. 341p. Dep. NTIS, PC A15/MF A01.

The mechanical properties analyses of the project coals were completed. As found by other researchers, there was no property which correlated with the grindability of the project coals. The mechanistic models for the three dry grinding systems were derived and are undergoing validation. Two special studies were completed. The first examined the grinding of coal in oil. The results were presented in an invited technical paper before the 1st International Coal Oil Mixture Conference. This is only the first of many technical papers that will evolve from this study. The second special study involved a comparison between two types of grinding media - the conventional ball and the cylpeb, a type of equidistant rod. All four coal grinding circuits - air swept ball mill; ball and race mill; hammer mill; wet overflow ball mill - were operated to generate data to validate the mechanistic models. The coal produced during these tests was made available to other DOE projects requesting material. In addition, the grinding facilities were used in support of coal grinding process information for several DOE demonstration projects.

2453 (NP—24146, pp 80-125) **Coal processing and utilization.** 1977. (In German).

In Steinkohlenbergbauverein annual report 1977.

The chapter on coal preparation and coal utilization deals with R & D activities of the Steinkohlenbergbauverein in the fields of coal preparation, coke production in horizontal chamber coking ovens, continuous coking, energy conversion, coal hydrogenation and coal chemistry as well as adsorption technology.

2454 (ORNL—5570) **Correlation of physical coal separations: Part I.** Hise, E.C. (Oak Ridge National Lab., TN (USA)). Sep 1979. Contract W-7405-ENG-26. 46p. Dep. NTIS, PC A03/MF A01.

Experimental separations of the inorganic material from a coal by the specific-gravity (wet), high-gradient magnetic (dry), and open-gradient magnetic (dry) processes were performed and analyzed to compare for Btu recovery vs efficiency of removal of pyrite and ash and to determine the degree of liberation of the inorganics by the crushing. It is shown that the liberated minerals can be separated from dry crushed coal by both the high-gradient magnetic separation (HGMS) and the open-gradient magnetic separation (OGMS) processes with an efficiency comparable to the specific-gravity (float-sink) process. Coal feed through the HGMS was by gravity with low-velocity transport air and through the OGMS by vibrating tray and by gravity free fall. The degree of liberation of the minerals was assayed by a set of specific-gravity separations. These separations were performed with size fractions in the range of -14 +100 mesh of Western Kentucky seam No. 9 coal in the laboratories of the Bureau of Mines (specific gravity), the Oak Ridge National Laboratory (ORNL) (open-gradient magnetic and specific gravity), and of a magnetic separator manufacturer (high-gradient magnetic). Several magnetic processes have been shown to separate efficiently the liberated minerals from dry crushed coal. The high-gradient magnetic separator can attract and retain the paramagnetic particles on the magnetized mesh. Production-scale machines suited for HGMS of dry crushed coal are commercially available. The open-gradient magnetic separator can deflect both the diamagnetic and the paramagnetic particles in a freely falling stream of coal into a spectrum that can be split to separate the minerals from the clean coal. The process, as demonstrated on a laboratory scale, appears to be simple and efficient and, therefore, merits further development.

2455 (ORNL—5571) **Separation of dry crushed coals by high-gradient magnetic separation.** Hise, E.C.; Wechsler, I.; Doulin, J.M. (Oak Ridge National Lab., TN (USA)). Oct 1979. Contract W-7405-ENG-26. 74p. Dep. NTIS, PC A04/MF A01.

The separation of pyritic sulfur and ash-forming minerals from dry crushed coal by means of a high-gradient magnetic separator was demonstrated, and the process parameters for separation were defined. Variables for the parametric test series included several grinds of two coals, particle size fractions, magnetic field strength, matrix, and transport fluid, direction, and velocity. Grinding and classifying equipment and techniques were evaluated. For several size fractions of both coals, all of the liberated pyritic sulfur and most of the liberated ash-forming minerals were separated. For the remaining size fractions, encouraging results were obtained. A preliminary flow sheet and cost estimate indicated that the capital and operating costs for classifying and separating 200 tons/hr range from $1.07 to $1.64 per ton of feed coal.

2456 **Proceedings of the 3rd international technical conference on slurry transportation.** Washington, DC; Slurry Transport Association (1978). 229p. (CONF-7803114—).

From 3. international technical conference on slurry transportation; Las Vegas, NV, USA (29 Mar 1978).

The Slurry Transport Association was formed in 1976 for the purpose of supporting the slurry transport industry, disseminating information, and coordinating the activities of those interested in the technology. Sessions were devoted at this conference to: economics and environment; preparation and power plant utilization; research and development; international projects; pipeline design and equipment developments; and rheology and test loops. A separate abstract was prepared for each of the 25 individual presentations for the DOE Energy Data Base (EDB). Twelve of the articles regarding coal transport were selected for Energy Abstracts for Policy Analysis (EAPA).

COMBUSTION

REFER ALSO TO CITATION(S) 2406, 2430, 3210, 3225, 3226, 3227, 3528, 3604

2457 (AD-A—063239) **Fuels: state of the art in industrial utilization. Final report.** Kong, P.; Lee, M.; Hathaway, S. (Army Construction Engineering Research Lab., Champaign, IL (USA)). Nov 1978. Contract MIPR-N00025-4-1041. 146p. NTIS PC A07/MF A01.

This study reviews the state of the art of industrial-scale boiler fuel use for supervisory personnel. Fuels considered were coal, petroleum fuel oil, and refuse. The sections on coal and oil deal with the basics of selection, equipment and technology for handling and storage, and equipment and technology of combustion. In addition, coal gasification processes are discussed. The section on refuse discusses the technology of converting refuse to energy (CRE). It describes in detail current major package CRE systems and considerations for co-firing refuse in boilers currently designed for firing coal.

2458 (AED-Conf—78-155-058) **Utilization of solid fuels with low calorific value for power generation in large power plants.** Grabowski, A. (Fraunhofer-Gesellschaft zur Foerderung der Angewandten Forschung e.V., Freiburg im Breisgau (Germany, F.R.). Inst. fuer Physikalische Weltraumforschung). 1978. 15p. (In German). (CONF-7804102—26). Dep. NTIS (US Sales Only), PC A02/MF A01.

From Systems exhibition energy within the context of the Hannover fair; Hannover, F.R. Germany (19 Apr 1978).

The mean calorific value of the hard coal used in Polish power plants for power generation varies with regard to the reference limiting value of 18,846 kj/kg set in international statistics. The calorific value of the brown coal used for electric power generation has been gradually decreasing, from 8,510 kj/kg in 1970 to 7,873 kj/kg in 1977. These low-grade coals have caused some operating problems in coal handling, and ash removal systems as well as in steam generators and their auxiliary systems. Apart from this, there are environmental problems. The paper gives solutions to the problems named above.

2459 (DOE/EV—0046(Vol.1), pp 149-165) **Environmental control: coal utilization program.** Wilzbach, K.E.; Livengood, C.D.; Farber, P.S. (Argonne National Lab., IL). Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

In-depth engineering and economic assessments of available and near-term control technologies have been made by the ANL staff and several subcontractors. The topics covered include coal cleaning, NO/sub x/ control, particulates collection, flue gas desulfurization and denitrification, low-Btu gasification with combined-cycle generation, and solvent refining of coal. The development of advanced technologies, such as MHD and fuel cells, is being monitored in-house together with such other fuel cycle elements as coal

transportation. Another important aspect of the program is the comparative evaluation of different control technologies. At present, the ANL comparative assessment model is only applicable to conventional combustion techniques. As performance and economic data become available on advanced techniques such as fluidized bed combustion, MHD, liquifaction, and gasification/combined cycle systems, this information will be incorporated into the comparative assessment model. Once this incorporation has been completed it will be possible for the Department of Energy, or other interested users, to evaluate the effects of these technologies on power generation while meeting environmental regulations on a site-specific basis.

2460 (DOE/EV—0046(Vol.1), pp 166-176) **Assessment of current and advanced NO/sub x/ control technology for coal-fired industrial boilers.** Sonnichsen, T.W. (KVB, Inc., Tustin, CA); Thompson, R.E.; Huang, H. Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

This paper is a synopsis of a study conducted for Argonne National Laboratory to examine the effectiveness of combustion modification methods for NO/sub x/ control applicable to coal-fired industrial boilers including low excess air, staged combustion and burner modifications. Boiler types considered included overfed and underfed stokers, spreader stokers, pulverized and cyclone fired units. Baseline (as-found) NO/sub x/ emissions from grate fired stokers were shown to be in the range of 200 to 300 ppM. Similarly, as-found emissions from suspension fired units were quite low as compared to comparably designed utility sized units. Low excess air was shown to be the most effective method on existing units reducing emissions by approximately 10%. Evaluation of staged combustion and burner modification, however, was limited due to current boiler designs. Major hardware modification/design and implementation are necessary before the potential of these techniques can be fully evaluated. The study emphasized the numerous operational factors that are of major importance to the user in selecting and implementing a combustion modification including energy considerations, incremental capital and operating costs, corrosion, secondary pollutants and retrofit potentials.

2461 (DOE/EV—0046(Vol.1), pp 525-541) **Sulfur dioxide control in fluidized-bed combustion of high sulfur coals.** Halow, J.S.; Grimm, U.; Mei, J.S. (Dept. of Energy, Morgantown, WV). Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

A program was initiated late last yeat at the Morgantown Energy Technology Center, Department of Energy to demonstrate a 90 percent sulfur retention capability in the 18-inch atmospheric fluidized-bed combustion (AFBC). This program was undertaken in response to concerns about the impact of possible New Source Performance Standards (NSPS) proposed by the Environmental Protection Agency in sulfur emissions. A high volatile bituminous coal with 4.42 percent of sulfur content was selected for this study. Greer limestone as well as tymochtee dolomite were used as bed material and sorbent. Combustion tests were carried out at various operating conditions to develop AFBC engineering and emissions data on this high sulfur coal. Ninety percent or greater of sulfur retention was attainable in several of the eighteen balance periods depending on operating conditions. The results of the present tests clearly demonstrate that the proposed new standards for sulfur dioxide emissions can be met by AFBC's. The required operating conditions could, however, have serious impact on AFBC economics.

2462 (DOE/EV—0046(Vol.1), pp 543-550) **Gas turbine catalytic combustors for coal derived fuels.** Bunker, W.W. (Dept. of Energy, Washington, DC). Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

Catalytic combustion for gas turbines is a unique process which promises very low NO/sub x/ emission levels at high efficiencies and comparable pressure drops. The Department of Energy (DOE) is expanding the catalytic work of EPA and NASA into the area of coal-derived fuels, both gases and liquids. On-going programs for the combustion of low Btu gas, medium Btu gas, and heavy liquids are described. Future plans for possible field tests are discussed.

2463 (DOE/EV—0046(Vol.1), pp 551-569) **Fluidized-bed combustion tests on lignites and subbituminous coals at the Grand Forks Energy Technology Center.** Goblirsch, G.; Ness, H. (Dept. of Energy, Grand Forks, ND). Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

The atmospheric fluidized-bed combustion of Western and Gulf Coast lignites and subbituminous coals offers a method of utilizing these low-sulfur, high-alkali coals with possibly little or no added sulfur sorbent. Tests using a 6-inch atmospheric fluidized-bed combustor showed that eight of ten Western coals could be burned without addition of limestone and meet the standards of 1.2 lb SO_2/MM Btu. The downward revision in the NSPS will change the design criteria for these low-rank coals, as well as high-sulfur bituminous coals, but the sulfur retention on ash will still make a substantial contribution. For the low-rank coals tested, the calcium-to-sulfur ratio ranged from 1 to over 4, and the sulfur retention from nearly 0 to over 90 percent. Reinjection of primary cyclone fly ash increased sulfur capture significantly, but not sufficiently to insure compliance of all low-rank coals under the NSPS standards. Bed temperature influenced sulfur retention in the range of 1250 to 1600°F, with maximum retention at 1400°F without ash reinjection and 1500°F with ash reinjection. During operation some of the coal ash agglomerated within the bed and was also deposited on the tube walls. Tests for characterizing gaseous and particulate emissions from the AFBC have been performed; preliminary results of these tests are presented in this paper. The physical and chemical characteristics of the fly ash produced in the AFBC with and without cyclone ash recycle are examined.

2464 (FE—1726-35A) **Engineer, design, construct, test and evaluate a pressurized fluidized bed pilot plant using high sulfur coal for production of electric power. Phase I: preliminary engineering. Technology support test report commercial fluidized long term erosion/corrosion test in a limestone kiln.** (Curtiss-Wright Corp., Wood-Ridge, NJ (USA). Power Systems Div.). Aug 1978. Contract EX-76-C-01-1726. 50p. Dep. NTIS, PC A03/MF A01.

The concept of using a pressurized fluidized bed-combined cycle power plant for producing clean, economical electric power from high sulfur coal is being developed. The C-W design approach uses an in-bed heat exchanger, with air as the coolant medium, both to control bed temperature and to extract useable heat from the bed. The heat exchanger is made from finned tubing, vertically oriented in the bed. Operating temperatures of the metal tubes are about 1500°F to 1650°F, the latter also being the maximum bed temperature. The high metal temperatures, and the aggressive combustion environment, can result in erosion and hot-corrosion (sulfidation) of the finned tubes. Little published data are available on the resistance of metal alloys to high temperature erosion-corrosion in actual fluidized bed coal combustors. For this reason a part of the program is directed toward the evaluation of alloys for the heat exchanger application. To gain experience with long time exposure in fluidized-beds, albeit not coal combustors, sub-sized finned tube bundles were installed in two operational, commercial, fluidized bed reactors, designed by Dorr-Oliver for industrial clients. One of these reactors is operated by the Pfizer Company in Adams, Mass., and is used to calcine limestone. Heat for the calcining process is produced by burning a No. 6 residual fuel oil within the limestone fluidized bed. It was believed that the sulfur and alkali-metal salt content in the fuel oil and limestone as well as the abrasiveness of the limestone would produce an erosive and corrosive environment somewhat similar to a coal-limestone fluidized bed. The tube bundle was uncooled and therefore operated at bed temperature (1500°F to 1600°F). After 4320 hours of operation, the calciner was shut-down for maintenance and the tube bundle removed for examination. The results of a metallurgical examination of the sub-scale heat exchangers are given.

2465 (FE—2468-43(Vol.1)) **Materials of construction for atmospheric fluidized bed coal combustion. Final report on Task 005.** Nangia, V.K. (Engineering Societies Commission on Energy, Inc., Washington, DC (USA)). Feb 1979. Contract EF-77-C-01-2468. 182p. Dep. NTIS, PC A09/MF A01.

A search for a combustion system able to burn raw coal with high sulfur content (4 to 5%) without requiring post-treatment for sulfur dioxide, oxides of nitrogen and particulates, has led to the concept of burning coal in a fluidized bed combustion (FBC) system at relatively lower tempratures. FBC systems are expected to offer both economic and operational advantages compared to conventional technology with appropriate environmental controls. Pressurized fluidized bed combustion technology offers certain advantages for implementation over AFBC systems, which are described. The purpose of this report is to review the present and past work on behavior of materials in the environment of AFBC systems with the main emphasis on its application in utility boilers; document all the available data; identify materials problem areas; define operating conditions in terms of temperature, pressure and erosive and corrosive environments; propose candidate materials of construction based on extrapolation of the available data and related experience from other technologies; and recommend areas needing further research development.

2466 (FE—2489-45) **Development of combustion data to utilize low-Btu gases as industrial process fuels. Project 61004 special report No. 8: boiler burner.** Waibel, R.T.; Fleming, E.S. (Institute of Gas Technology, Chicago, IL (USA)). May 1979. Contract EX-76-C-01-2489. 40p. Dep. NTIS, PC A03/MF A01.

Data were gathered to determine the performance of a boiler burner with a gun-type fuel injector when retrofit with three low-Btu gases; the performance of natural gas was used as a base line for comparison. The burner was fired on the IGT pilot-scale test fur-

nace, simulating one burner in a multiburner array of an industrial boiler. The low-Btu fuel gases used for these combustion trials were Koppers-Totzek oxygen (KTO), Wellman-Galusha air (WGA), and Winkler air (WA). In order to fire the low-Btu gases at the 3.0 million Btu/hr rate and upstream pressure of 30 psia used for natural gas, the fuel injector had to be modified. Modifications consisted of increasing the sizes of the fuel orifices, permitting delivery of the required fuel volume at sonic velocity. With the appropriate fuel injector, all the low-Btu fuels exhibited stable flames at fuel enthalpy inputs of 3.0 million Btu/hr. All the low-Btu fuel gases had longer flame lengths than natural gas, although not long enough to create flame impingment problems. The thermal efficiencies of the low-Btu gases ranged from 29.5% for KTO to 26% for WA compared with 32% for natural gas.

2467 (FE—2516-9) **Centrifugal fluidized combustion of coal. Final report.** Levy, E.K.; Chen, J.C. (Lehigh Univ., Bethlehem, PA (USA)). Jan 1979. Contract EX-76-S-01-2516. 130p. Dep. NTIS, PC A07/MF A01.

A laboratory test unit was built; and batch experiments on bed startup, minimum fluidization, and pressure drop were performed using room temperature air at atmospheric pressure. Particular attention was given to the effects of grid pressure drop, grid taper angle, mass of bed material, speed of rotation, and particle size and density on fluidization. The batch experiments demonstrated that, over the range of conditions studied, it is possible to start up a centrifugal fluidized bed (CFB) from rest, that the system fluidizes in a predictable fashion, and that the minimum fluidization velocities and bed pressure drops are in good agreement with the theoretical models developed for the CFB. Test sections based on two different techniques for operating a CFB with continuous feed and removal were designed and fabricated. The experimental data indicate that with these techniques, it is possible to feed and remove solids continuously and achieve a stable bed thickness in a rotating fluidized bed. Experiments performed on particle elutriation show that the air flow rate at which particle loss is initiated is a strong function of the angular velocity of the bed and the bed thickness. At higher flow rates, the rate of particle loss depends on air flow rate, angular velocity and bed thickness.

2468 (FE—2694-T1) **Fuel extension by dispersion of clean coal in oil. Second quarterly report, February-May 1978.** Burgess, L.E. (Gulf and Western Advanced Development and Engineering Center, Swarthmore, PA (USA)). 19 Jun 1978. Contract EF-77-C-01-2694. 129p. Dep. NTIS, PC A07/MF A01.

The work of the second period showed that the initial observation of a chemical grafting (CG) reaction in which cracker gasoline improved the dispersion stability properties of Pittsburgh seam coal in COM was valid. Repeating this experiment with several petroleum unsaturated products further established the principal that CG reactions improved the dispersion stability of COM. The first major milestone of this program was therefore achieved with the conclusion that chemical grafting with low cost monomers improves the dispersion stability of COM. This work also proved that chemical grafting was occurring. The first proof involved elimination of the grafting initiator, with settling results that were similar to the control. The second proof showed by titration that the treated coal had oleic acid attached. This work also showed that chemically grafted coal is olephilic and hydrophobic. It mechanically dewaters with ease compared to the control. A new improved selective agglomeration beneficiation process shows promise. Use of the ingredients of low cost tall oil as chemical grafting agents may almost eliminate COM settling.

2469 (FE—4203-T1) **Pulverized coal firing of aluminum melting furnaces. First technical quarterly report for period ending September 30, 1978.** West, C.E. (Aluminum Co. of America, Alcoa Center, PA. Alcoa Labs.). Jan 1979. Contract EM-78-C-01-4203. 21p. Dep. NTIS, PC A02/MF A01.

The ultimate objective of this program is the commercial demonstration of an efficient, environmentally acceptable coal firing process suitable for implementation on melting furnaces throughout the aluminum industry. To achieve this goal, the program has been divided into two phases. During Phase I, detailed research and development will be performed to perfect a staged, slagging, cyclone burner for direct coal firing of a 40,000 lb open hearth aluminum melting furnace. Additives will be incorporated to remove sulfur and ash during the combustion process, thus precluding the need for downstream cleanup equipment. Also, two separate heat recuperation techniques will be evaluated. This work will be performed at Alcoa's ingot plant in Arnold, Pennsylvania (a production facility until the late 1950's), which is now a full-scale laboratory dedicated to investigations of alternate fuels, melting, ingot casting, and metal treatment. Phase II implementation is currently planned for Alcoa's Lafayette, IN, Works, where two of the ingot plant's five open hearth melting furnaces will be converted to utilize coal. In addition to confirmation of data gathered in Phase I, the effect of extended production schedule operation on equipment and efficiencies will be determined.

2470 (OTA-E—86) **Direct use of coal: prospects and problems of production and combustion.** (Office of Technology Assessment (U.S. Congress), Washington, DC). 1979. 427p. GPO.

Coal production in the United States will more than double by the year 2000, to as much as 2 billion tons per year. The investments in facilities, man-power, and technologies for the mining, transportation, and use of such vast quantities of coal will be immense. This report assesses the benefits and risks of such a massive shift to coal and away from other fuels. It deals with the social, economic, physical, and biological impacts of such a shift. It examines the complete coal system, from extraction to combustion, including the key steps and institutions that policy can influence. The environmental impacts and possible effects on the public health are documented. Occupational and community impacts are examined. Technologies under development that might reduce costs, increase convenience of use, or mitigate negative impacts are reviewed.

2471 **Fluidized-bed combustion of coal with lime additives. kinetics and mechanism of regeneration of the lime sorbent.** Chen, J.M.; Yang, R.T. (Brookhaven Natl Lab, Upton, NY). *Ind. Eng. Chem., Fundam.;* **18**: No. 2, 134-138(May 1979).

The apparent solid-solid reaction between CaS and $CaSO_4$ is the rate-controlling reaction in the lime sorbent regeneration for fluidized-bed combustion of coal, as well as in some other important industrial processes such as the sulfuric acid-cement process. A two-step mechanism for this reaction involving SO_3 was determined. The rate-controlling step in the mechanism is the decomposition of $CaSO_4$ to form CaO and SO_3. Kinetics and rate expressions are established for the overall reaction and the separate steps. Results are also presented for the kinetics and the thermodynamics of all the possible reactions under the conditions of the aforementioned processes.

MARKETING AND ECONOMICS

2472 (ANL/CNSV-TM—13) **Industrial demand for western coal in the Great Lakes region.** Krohm, G.C. (Argonne National Lab., IL (USA)). Sep 1979. Contract W-31-109-ENG-38. 55p. Dep. NTIS, PC A04/MF A01.

The Great Lakes industrial coal market, though currently much smaller than utility use, is expected to grow by as much as 3% per year until 1985. Although the potential for industrial coal use appears to be growing modestly, the share of this market captured by Western coal is critically affected by air quality regulations. Existing and projected ambient air quality violations in the vicinity of port cities will prohibit new coal use. This will be a particularly severe constraint in the center of the industrial core areas of Buffalo, Erie, Cleveland, Toledo, and Detroit. In addition to ambient air quality problems, more stringent New Source Performance Standards may make it prohibitively expensive to burn coal. The economic advantage of Western coal may be minimal in comparison to locally available high-sulfur coal because it costs just about as much to use a high-efficiency scrubber with low-sulfur coal as with high-sulfur coal. Under a standard of 1.2 lb SO_2 per million Btu of heat input, Western coal can be expected to capture a large share of the new boiler market within 75 miles of the Great Lakes ports. With a sulfur standard more stringent than the above, the market for Western coal will vanish even for users immediately adjacent to the port. Western coal is only attractive in the East due to its low sulfur content, which under some conditions allows the end user to avoid expensive sulfur control technologies. The Great Lakes shipping system represents the most economic way of moving coal from the Western states to major portions of the industrial Midwest and Northeast. The Great Lakes system can move coal to users in the vicinity of port cities at costs that are less than half the cost of the most economic rail route.

2473 (DOE/RA/2625—1) **Analysis of industrial markets for low and medium Btu coal gasification.** (Booz, Allen and Hamilton, Inc., Bethesda, MD (USA)). 30 Jul 1979. Contract ET-78-C-01-2625. 281p. Dep. NTIS, PC A13/MF A01.

Low- and medium-Btu gases (LBG and MBG) can be produced from coal with a variety of 13 existing and 25 emerging processes. Historical experience and previous studies indicate a large potential market for LBG and MBG coal gasification in the manufacturing industries for fuel and feedstocks. However, present use in the US is limited, and industry has not been making substantial moves to invest in the technology. Near-term (1979-1985) market activity for LBG and MBG is highly uncertain and is complicated by a myriad of pressures on industry for energy-related investments. To assist in planning its program to accelerate the commercialization of LBG and MBG, the Department of Energy (DOE) contracted with Booz, Allen and Hamilton to characterize and forecast the 1985 industrial market for LBG and MBG coal gasification. The study draws five major conclusions: (1) There is a large technically feasible market potential in industry for commercially available equipment - exceeding 3 quadrillion Btu per year. (2) Early adopters will be

principally steel, chemical, and brick companies in described areas. (3) With no additional Federal initiatives, industry commitments to LBG and MBG will increase only moderately. (4) The major barriers to further market penetration are lack of economic advantage, absence of significant operating experience in the US, uncertainty on government environmental policy, and limited credible engineering data for retrofitting industrial plants. (5) Within the context of generally accepted energy supply and price forecasts, selected government action can be a principal factor in accelerating market penetration. Each major conclusion is discussed briefly and key implications for DOE planning are identified.

2474 (EPRI-EA—907(Vol.1)) **CRA/EPRI Coal Market Analysis System. Volume 1. Overview. Final report.** (Charles River Associates, Inc., Boston, MA (USA)). Jul 1979. 57p. Dep. NTIS, PC A04/MF A01.

The CRA/EPRI Coal Market Analysis System (CMAS) forecasts minemouth coal prices and production for coal by rank and sulfur type for major coal-producing regions. The system uses a mathematical programming model to solve for market clearing prices and production of a spatially competitive market, in which users choose the lowest cost fuel source and competition among producers is sufficient to prohibit excess profits. The model thus provides a framework for analyzing the spatial interaction of coal demand, supply, and transportation. The system is designed to analyze effects of alternative assumptions about key factors that affect price and production, such as sulfur emission regulations, coal mining wage trends, mining equipment cost trends, productivity trends, coal resource availability, tax policies, and coal transport rate trends. In all cases, coal supply is represented by an upward sloping function with the marginal cost of production increasing as production increases. Utility coal demand by Reliability Council is an exogenous input to the model and is allocated to demand regions using information on locations of generating stations and their emission regulations. Nonutility demand for metallurgical, export, retail, and other mining and manufacturing synfuels are also specified. Transportation costs reflect unit train rates and expected escalation in these rates. The documentation for the system consists of four volumes. EA907-Volume 1, ERA/EPRI Coal Market Analysis System: Overview, contains an overview of the CRA/EPRI CMAS, touching on methodology, system organization, and data base content.

2475 (EPRI-EA—907(Vol.2)) **CRA/EPRI Coal Market Analysis System. Volume 2. Technical background. Final report.** (Charles River Associates, Inc., Boston, MA (USA)). Jul 1979. 295p. Dep. NTIS, PC A13/MF A01.

The CRA/EPRI Coal Market Analysis System (CMAS) forecasts minemouth coal prices and production for coal by rank and sulfur type for major coal-producing regions. The system uses a mathematical programming model to solve for market clearing prices and production of a spatially competitive market, in which users choose the lowest cost fuel source and competition among producers is sufficient to prohibit excess profits. The model thus provides a framework for analyzing the spatial interaction of coal demand, supply, and transportation. The system is designed to analyze effects of alternative assumptions about key factors that affect price and production, such as sulfur emission regulations, coal mining wage trends, mining equipment cost trends, productivity trends, coal resource availability, tax policies, and coal transport rate trends. EA907-Volume II, CRA/EPRI Coal Market Analysis System: Technical Background discusses in depth the methodologies used in the model to forecast coal demand, coal supply, and transportation.

2476 (EPRI-EA—907(Vol.3)) **CRA/EPRI Coal Market Analysis System. Volume 3. Software documentation. Final report.** (Charles River Associates, Inc., Boston, MA (USA)). Jul 1979. 171p. Dep. NTIS, PC A08/MF A01.

The CRA/EPRI Coal Market Analysis System (CMAS) forecasts minemouth coal prices and production for coal by rank and sulfur type for major coal-producing regions. The system uses a mathematical programming model to solve for market clearing prices and production of a spatially competitive market, in which users choose the lowest cost fuel source and competition among producers is sufficient to prohibit excess profits. The model thus provides a framework for analyzing the spatial interaction of coal demand, supply, and transportation. The system is designed to analyze effects of alternative assumptions about key factors that affect price and production, such as sulfur emission regulations, coal mining wage trends, mining equipment cost trends, productivity trends, coal resource availability, tax policies, and coal transport rate trends. EA907-Volume III, CRA/EPRI Coal Market Analysis System: Software Documentation contains computer program flow charts, file descriptions and instructions for running the computerized system.

2477 (EPRI-EA—907(Vol.4)) **CRA/EPRI Coal Market Analysis System. Volume 4. Database preparation.** (Charles River Associates, Inc., Boston, MA (USA)). Jul 1979. 188p. Dep. NTIS, PC A09/MF A01.

The CRA/EPRI Coal Market Analysis System (CMAS) forecasts minemouth coal prices and production for coal by rank and sulfur type for major coal-producing regions. The system uses a mathematical programming model to solve for market clearing prices and production of a spatially competitive market, in which users choose the lowest cost fuel source and competition among producers is sufficient to prohibit excess profits. The model thus provides a framework for analyzing the spatial interaction of coal demand, supply, and transportation. The system is designed to analyze effects of alternative assumptions about key factors that affect price and production, such as sulfur emission regulations, coal mining wage trends, mining equipment cost trends, productivity trends, coal resource availability, tax policies, and coal transport rate trends. EA907-Volume IV, CRA/EPRI Coal Market Analysis System Database Preparation describes data sources and data preparation methods for each data file. This computerized system, written in FORTRAN, is designed to use the IBM-370 Mathematical Programming System Extended.

2478 (NP—24042) **National Coal Board: report and accounts, March 26, 1978-March 31, 1979.** (National Coal Board, London (UK)). 1979. 94p. Dep. NTIS (US Sales Only), PC A05/MF A01.

The importance of coal, which became evident once again after the massive oil price increases of 1973/4, has been further underlined by the disturbance in the oil market occasioned by the troubles in Iran. In spite of North Sea oil, Britain has not escaped the repercussions of this situation. The case for a long term policy for developing Britain's energy resources seems now generally accepted. The coal industry's plan for expansion was agreed in 1974 and has been applied consistently ever since. It is based on more exploration, investmant, and research. The capital cost of this expansion plan is substantial and is creating serious short-term financing problems for the industry. But it is a vital element in Britain's energy insurance and there can be no doubt of the need to persevere with it. The industry's success depends not only on increasing levels of carefully directed investment but also on getting results as soon as possible from that investment. In 1978/9 these results, in the form of improving productivity, began to emerge. Productivity at the face rose by 8% and overall by more than 2%. In development drivages (that is, in the work needed to create new faces) the improvement was 5%.

2479 (NP—24043) **National Coal Board statistical tables 1978/9.** (National Coal Board, London (UK)). 1979. 14p. Dep. NTIS (US Sales Only), PC A02/MF A01.

2480 (SRC—7017-5) **Potential industrial markets for lignite.** Limaye, D.R.; White, D.M. (Synergic Resources Corp., Bala-Cynwyd, PA (USA)). Apr 1979. 23p. Dep. NTIS, PC A02/MF A01.

This working paper addresses the major factors influencing the potential utilization of lignite as an industrial fuel in Arkansas and Louisiana. The technical, economic and regulatory aspects of industrial markets for lignite are reviewed and a brief discussion of the potential of lignite use in the industrial belt in southern Louisiana as well as for existing and new industry in the lignite region in Arkansas and Louisiana, is presented. This paper was prepared in support of the development of the Lignite Research Agenda for the Ozarks Regional Commission. During the development of the Agenda, Synergic Resources Corporation personnel worked in close cooperation with an under the supervision of the Lignite Steering Committee. Members of this Steering Committee included representatives of the local economic development districts, the two state energy offices, state geological surveys and Commission staff.

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 2442, 2446

REGULATIONS

2481 (DOE/TIC—10276) **Ozarks Regional Commission Lignite Research Agenda. Executive summary.** (Synergic Resources Corp., Bala-Cynwyd, PA (USA)). May 1979. 10p. Dep. NTIS, PC A02/MF A01.

The Ozarks Regional Commission (ORC), following up on the recommendations of its Regional Energy Alternatives Study, conducted a Lignite Conference in May 1978 to bring together knowledgeable and interested parties to discuss the opportunities and constraints for lignite development. This conference focused public attention on the potential benefits and impacts of lignite development in Arkansas and Louisiana, and identified the need for additional information regarding the lignite resource base, characteristics, utilization potential and developmental impacts. ORC therefore commissioned this study to generate a Lignite Research Agenda. The

principal objective of this project was to develop a Lignite Research Agenda to be undertaken by the public sector to establish a concerted regional effort of balanced and orderly development of the lignite resources in Arkansas and Louisiana. The research agenda addresses the following areas: Lignite resource base, technologies for conversion/utilization, market potential for lignite, environmental impacts of lignite, socio-economic impacts of lignite, regulatory and institutional factors, and information dissemination. The summarized research agenda include: Prioritization of research areas, research objectives and potential benefits, definition of research programs, identification of specific projects, schedule, funding requirements, and co-funding possibilities and relationship to other existing research programs.

2482 (SRC—7017-2) **Socio-economic implications of lignite development. Final report.** Limaye, D.R.; White, D.M. (Synergic Resources Corp., Bala-Cynwyd, PA (USA)). Apr 1979. 38p. Dep. NTIS, PC A03/MF A01.

This working paper addresses the socio-economic implications of lignite development in the rural areas of Arkansas and Louisiana. It draws upon the experience with lignite development in Texas as well as the coal and lignite development in the West. The general implications of lignite development are identified and discussed and are illustrated with a case study of Mt. Pleasant, Texas. Requirements for future research relevant to Arkansas and Louisiana are identified.

2483 (SRC—7017-4) **Review of conversion technologies for Gulf Coast lignite.** (Synergic Resources Corp., Bala-Cynwyd, PA (USA)). Apr 1979. 29p. Dep. NTIS, PC A03/MF A01.

This paper briefly describes the current and emerging status of technologies for conversion and utilization of lignite. R and D programs sponsored by the Department of Energy, Electric Power Research Institute, Gas Research Institute and utilities are examined and additional research requirements specific to Gulf Coast lignites are identified. Policy implications for the Ozarks Regional Commission are summarized and specific action items for future research are defined. This paper was prepared in support of the development of the Lignite Research Agenda for the Ozarks Regional Commission. During the development of the Agenda, Synergic Resources Corporation personnel worked in close cooperation with and under the supervision of the Lignite Steering Committee. Members of this Steering Committee included representatives of the local economic development districts, the two state energy offices, state geological surveys and Commission staff.

2484 **Impact of the 1977-78 coal miners' strike on Illinois electric utilities.** Sanghi, A.K.; Burbridge, C.A. Springfield, IL; Illinois Bureau of the Budget (1979). 60p. (NP—24113). Illinois Bureau of the Budget, Office of Planning, Room 315, Lincoln Tower Plaza, 524 S. Second St., Springfield, IL 62706.

Electric utilities in Illinois and Ohio were affected by the coal miners' strike of 1977-1978. However, the situation in Illinois was not as grave as in Ohio. While utilities in both states were able to increase coal stocks prior to the strike, this action was not sufficient to see the utilities through the strike. Illinois utilities increased substantially the amount of coal purchased from western mines in order to maintain their fuel stocks and continue service. Ohio utilities, on the other hand, found it necessary to import large quantities of electricity from other regions in order to continue service. In Ohio it was also necessary to curtail service both voluntarily and involuntarily in order to maintain coal stocks at a desirable level. Three factors appeared to influence the actions of the utilities in the two states. First is the amount of generating capacity relying on coal. Illinois' utilities are, as an aggregate, fairly diversified by type of fuel used for generation. Ohio utilities, on the other hand, are highly dependent on coal. Second is the diversity of the sources of coal. While utilities in both states utilize coal primarily from the region in which they are located, Illinois utilities exhibited a greater tendency to purchase coal from outside their region both prior to and during the strike. Finally, it appeared that the expectations of the utilities concerning the magnitude of the strike influenced the utilities' decisions to alter coal consumption and purchasing practices. These conclusions are supported by the analysis of the strike's impact on the four major utilities in Illinois.

PETROLEUM

RESERVES

2485 (NP—24125) **Energy potential North Sea.** (Wirtschaftsverband Erdoel- und Erdgasgewinnung e.V., Hannover (Germany, F.R.)). 1977. 16p. Dep. NTIS (US Sales Only), PC A02/MF A01.

Petroleum and gas reserves in the North Sea, offshore drilling technology, submarine pipeline laying and the supply of goods necessary for offshore technology are reported.

GEOLOGY AND EXPLORATION

REFER ALSO TO CITATION(S) 3495, 3565

2486 **Method and core barrel apparatus for obtaining and retrieving subterranean formation samples.** Thompson, C.M.; Spehrley, C.W.; Thompson, C.T. (to American Coldset Corp.). US Patent 4,142,594. 6 Mar 1979. Filed date 6 Jul 1977. 24p.

Core barrel apparatus and a method for obtaining and retrieving sealed core samples of subterranean formations are disclosed. The core barrel apparatus comprises inner and outer core barrels. The upper portion of the outer core barrel is adapted to be connected to a drill string. A core bit for cutting a core sample is mounted on the lower portion of the outer core barrels. The inner core barrel comprises a sample chamber for receiving a core sample as it is formed at the bottom of a bore hole and an expansion chamber for receiving sample fluids. The sample chamber and expansion chamber are selectively connected to one another. The expansion chamber is sealed closed while the sample is being cut and received within the sample chamber. The lower portion of the sample chamber adjacent the core bit is sealed by a flap-valve which includes a flexible flap member. The flexible flap member is deflected from its normal form of a flat disc into a semi-cylindrical form and stored adjacent to the inner circumference of the sample chamber while the sample is being cut. Once the core sample is within the sample chamber, the flap member is permitted to spring into its flat disc form and extend across the opening in the lower portion of the sample chamber in order to seal the core sample within the chamber. Thereafter the expansion chamber is opened to the sample chamber. As the apparatus is raised toward the surface and the pressure within the bore hole decreases, the expansion chamber expands in response to the pressure of the fluid within it and thereby maintains the pressure within the expansion chamber at or relatively near the bore hole pressure. 21 figures, 40 claims.

DRILLING AND PRODUCTION

REFER ALSO TO CITATION(S) 2421, 3452, 3531

2487 (BETC—79/3) **Contracts and grants for cooperative research on enhanced oil recovery and improved drilling technology. Progress review No. 19, quarter ending June 30, 1979.** Linville, B. (ed.). (Department of Energy, Bartlesville, OK (USA). Bartlesville Energy Technology Center). Sep 1979. 126p. Dep. NTIS, PC A07/MF A01.

The contracts and grants for field projects and supporting research are arranged according to: chemical flooding, carbon dioxide injection, thermal/heavy oil, Western gas, improved drilling technology, general research, residual oil, environmental, and petroleum technology. (DLC)

2488 (DOE/EV—0046(Vol.1), pp 128-142) **Environmental aspects of enhanced oil recovery.** Donaldson, E.C. (Dept. of Energy, Bartlesville, OK). Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

Enhanced oil recovery processes are still in the stage of development. The transition from pilot testing to full scale field application depends upon a complex interaction of foreign and domestic politics and economy, as well as the success of field research that may improve the economy of enhanced oil recovery processes. Underlying all development and expansion activities associated with oil production is the constant need for protection of the environment from pollution. However, unanswered questions regarding the environmental consequences of enhanced oil recovery activities should be addressed during the period of pilot field testing which is now in progress. Oil displacement by injection of brines (the waterflood process) entails the surface processing of large quantities of saline waters as the waterflood progresses creating the potential for pollution of surface waters and shallow fresh water aquifers. Improved waterflooding techniques involve the introduction of surface active agents (detergents), caustics, and organic polymer compounds (particularly polyacrylamide) thus producing a step increase in the potential for pollution. It is increased another step when the micellar-polymer process is employed since the micellar solution is a mixture of surfacant, oil, water, and a cosurfactant (usually an alcohol). Enhancement of oil production by thermal methods adds another dimension to the environmental hazards through air pollution from steam generators and the produced fluids. Other field operations, such as drilling and renovation of wells,

create local environmental hazards but these are becoming regional concerns as the search for new oil and the reactivation of oil fields accelerates.

2489 High pressure cleaning and pumping method and apparatus for oil well production. Wilson, P.M.; Presley, C.L. (to Kobe, Inc.). US Patent 4,159,036. 26 Jun 1979. Filed date 8 Jun 1978. 8p.

High pressure product fluid from a petroleum well goes into a high pressure separation vessel where preliminary phase separation of the constituents takes place. Oil and gas leave the preliminary separator by a flow line. Power fluid for a triplex pump flows from the high pressure separator into a separator tank that opens to atmosphere. Here, further separation of the phases takes place and power fluid low in abrasive solid content is taken off by a charging pump and fed to the triplex pump. The triplex pump increases the head of the power fluid and introduces it to the well. The power fluid may be either water or oil.

2490 Tertiary oil recovery process utilizing a preflush. Kalfoglou, G.; Flournoy, K.H. (to Texaco Inc.). US Patent 4,157,306. 5 Jun 1979. Filed date 9 Jan 1978. 10p.

An adjusted salinity and hardness, aqueous preflush containing a thickening material which can be, for example, a hydrophilic material such as polyacrylamide, polysaccharide, polyvinyl aromatic sulfonate, polyethylene oxide, methyl cellulose, etc. or colloidal silica, etc. in a concentration sufficient to increase the viscosity of the adjusted salinity aqueous preflush fluid is injected into a subterranean, petroleum-containing formation. Optionally, the preflush fluid may contain a sacrificial agent, such as sodium tripolyphosphate, etc. The high salinity formation water is efficiently displaced by viscous low salinity aqueous preflush fluid to increase the effectiveness of a subsequently injected high salinity sensitive single surfactant solution. The surfactant may be displayed by a mobility buffer solution, which then may be displaced by water. 3 claims.

2491 Gas lift well with improvement. Winders, R.E. (to Texaco Inc.). US Patent 4,154,299. 15 May 1979. Filed date 19 Dec 1977. 6p.

The combination includes a gas lift well that has a Christmas tree coupled to the casing and to the tubing in the well. There is a flow line to receive liquid product and a choke connected between the flow line and the tubing. The improvement includes a lateral Y connected to the top of the tubing with a streamlined flow path connecting a lateral branch of the Y, from the well side of the choke, to the flow line. 6 claims.

2492 Well tubing hanger. Gano, J.C. (to Otis Engineering Corp.). US Patent 4,154,298. 15 May 1979. Filed date 21 Nov 1977. 46p.

A well system and method for completing petroleum oil and gas wells are described. The system can be applied to extreme environmental settings such as platform, sub sea, and floating vessel operations, and frozen regions such as the Arctic. The system effectively defines a downhole wellhead including weight supporting apparatus in which the tubing hanger is supported and a pack-off with the casing for minimizing the effects of structural damage at the surface end of the well system. The system includes a tubing hanger releasably lockable in a casing at a downhole location and having sealing means for sealing the annulus within the casing around the hanger, a ball valve package lock releasably lockable in the tubing hanger, tubing strings connected with the ball valve package lock and extending upwardly therefrom, including tubing valves, a safety joint connected with the tubing strings above the valves, tubing strings connected with the safety joint extending upwardly to a tubing head at the wellhead, control fluid conduits connected from the tubing head through the safety joint to the ball valve package lock and tubing hanger for manipulation of the system during various phases of operation, and a composite handling string for running and pulling the well system including either of a slip joint or a hydraulic stop and orienting tool. 5 claims.

2493 Chrome lignosulfonates as additives in oil recovery processes involving chemical recovery agents. Kalfoglou, G. (to Texaco Inc.). US Patent 4,142,582. 6 Mar 1979. Filed date 10 Nov 1977. 14p.

A process for producing petroleum from subterranean formations is disclosed wherein production from the formation is obtained by driving a fluid from an injection well to a prodution well. The process involves injecting via the injection well into the formation an aqueous solution of a chrome lignoulfonate complex as a sacrificial agent to inhibit the deposition of surfactant and/or polymer on the reservoir matrix. The process may best be carried out by injecting the chrome lignosulfonate complexes into the formation through the injection well ahead of or mixed with either a polymer, a surfactant solution and/or a micellar dispersion. This mixture would then be followed by a drive fluid such as water to push the chemicals to the production well. 10 claims.

2494 Micellar flooding process for heterogeneous reservoirs. Holm. L.W. (to Union Oil Company of California). US Patent 4,140,183. 20 Feb 1979. Filed date 13 Feb 1978. 12p.

A process for recovering oil from a heterogeneous subterranean reservoir having strata of widely varying permeability by injecting therein via a well a slug of a micellar solution followed by an aqueous drive fluid wherein, at some time prior to the injection to all of the slug of the micellar solution, there is injected into the reservoir one or more aqueous solutions of reagents that react in the reservoir to form a plugging material, one of which reagents contains a polyvalent cation. After the plugging material has formed, the well is produced to remove from the reservoir the unreacted reagent containing a polyvalent cation which polyvalent cation would otherwise react with and reduce the efficiency of the subsequently injected micellar solution. 25 claims.

2495 Tectonic map of the overthrust belt: Western Wyoming, Southeastern Idaho and Northeastern Utah, showing current oil and gas drilling and development. Blackstone, D.L. Jr. (comp.). Laramie, WY; Geological Survey (1979). vp. (NP—24073). Geological Survey of Wyoming, Box 3008, University Station, Laramie, WY 82071.

This map shows areas of current oil and gas drilling and production in this area. (DLC)

PROCESSING

2496 Selected aromatic hydrocarbon production. Addison, G.E. (to UOP Inc.). US Patent 4,158,025. 12 Jun 1979. Filed date 13 Mar 1978. 12p.

Selected aromatic hydrocarbon concentrates - benzene, mixed xylenes - are produced by way of a combination process which involves catalytic reforming followed by dealkylation. Although the process affords flexibility respecting the precise aromatic concentrate produced, it is particularly directed toward the maximization of benzene.

2497 Process for the desulfurization of petroleum coke. Alford, H.E.; Marsh, E.N. (to Standard Oil Co. (Indiana)). US Patent 4,146,434. 27 Mar 1979. Filed date 7 May 1976. 8p.

Delayed coke especially manufactured for use in graphite can be effectively desulfurized by calcining in a hydrocarbon fuel-fired calciner in the temperature range of 2700°F to 2900°F without adversely affecting the strength of the coke or the coefficient of thermal expansion of the graphitized coke. 6 claims.

2498 Penetration enhanced fluid mixing method for thermal hydrocarbon cracking. Kearns, J.D. (to Union Carbide Corp.). US Patent 4,142,963. 6 Mar 1979. Filed date 7 Jun 1977. 8p.

Thermal cracking of hydrocarbons by the introduction of liquid feedstock into a stream of hot gaseous combustion products, the method comprising introducing and mixing said liquid as at least one stream in said hot gaseous combustion product stream while concurrently surrounding and shrouding each of said liquid streams with a co-injected annular stream of gas having a velocity sufficient to supplement momentum without substantial dilution of the combustion product stream. 6 figures, 12 claims.

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 2679

MARKETING AND ECONOMICS

2499 (DOE/EIA—0102/35) Oil supply shortfalls resulting from a Middle East cut-off, 1978-1980. Analysis Memorandum. Kilgore, W.C.; Butler, G.D. (Department of Energy, Washington, DC (USA). Energy Information Administration). 26 Jan 1978. 14p. NTIS, PC A02/MF A01.

This interruption scenario was simulated using the Petroleum Allocation (PAL) computer model. The model simulates total world trade in both crude oil and refined products and, in the case of a supply emergency, allocates available petroleum supplies among member countries of the International Energy Agency as dictated in the International Energy Program.

2500 (DOE/EIA—0103/13) Medium-run oil and gas supply model, 1977 data update. Research Memorandum No. 78-015. (Department of Energy, Washington, DC (USA). Energy Information Administration). Dec 1977. 54p. NTIS, PC A04/MF A01.

This publication documents the 1977 data update of the model. This report is divided into three sections. The first two sections deal with data used in the oil and gas submodels which translate drilling and recovery data into annual production quantities by region. The third section deals with an update of the economic submodels for both oil and gas. Each section contains a listing of the relevant data inputs for each submodel with regional and time period

(i.e., quarterly, annual) requirements specified as well as an indication of the sensitivity of the model to each of the data inputs. This list is then followed by a description of the development of each of the data inputs.

2501 (DOE/EIA—0184/16) **Petroleum supply vulnerability, 1985 and 1990. Analysis report AR/IA/79-41.** Butler, G.D. (Department of Energy, Washington, DC (USA). Energy Information Administration). Sep 1979. 120p. Dep. NTIS, PC A06/MF A01.

Four different projections of world oil supply and demand were selected for use as the basis of the supply disruption simulations. Three of the selected projection series (SPRLOW, SPRMID, and SPRHIGH) incorporated the energy initiatives proposed by President Carter in his July 15, 1979 address to the nation. The fourth projection series (SPRHIGH2) assumes U.S. energy initiatives up to, but not including, the July 15th proposals. The low vulnerability case (SPRLOW) includes the lowest level of US imports. The assumed low OPEC production capacity in this case causes world oil prices to escalate sharply, which then encourages domestic production but curtails domestic consumption. The high vulnerability case (SPRHIGH) exhibits a continued high dependence on foreign imports. This case assumes high OPEC production capacity, and OPEC continues increasing its production until capacity is reached in 1983. This results in a price decline (in real terms) in the early 1980's. The SPRHIGH2 case, which excludes the July 15 initiatives, shows an even greater dependence on foreign imports due to less stringent energy initiatives related to enhanced oil recovery, synthetics production, and import ceilings. Eleven disruption scenarios were simulated for the years 1985 and 1990 for each of the four projection series; the expected supply shortfalls to the United States resulting from each of these disruptions are tabulated. Any strategy relating to the drawdown of the Strategic Petroleum Reserve (SPR) is not included in the calculation of the shortfalls. All of the shortfalls assume that the International Energy Program has been implemented for the allocation of remaining oil supplies.

2502 (INKA-Conf—79-095-002) **Problems of peak loads in the petroleum industry.** Burchard, H.J. (Mineraloelwirtschaftsverband e.V., Hamburg (Germany, F.R.)). 1979. 11p. (In German). (CONF-7905117—2). Dep. NTIS (US Sales Only), PC A02/MF A01.

From Conference on power demand and supply - analysis and strategies; Schliersee, F.R. Germany (16 May 1979).

A survey of the specific characteristics of the petroleum industry are given which result especially from the most important difference between this and the other leading forms of energy, concerning energy supply, i.e., the temporal interval between production and availability. Storage- and transport procedures in between make specific reactions at peaks of demand possible. The monthly home sale of engine gas, light fuel oil, and heavy fuel oil are given for the years 1975 to 1978 for a specific plant for comparison purposes.

WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 3293

2503 **Cyclonic distillation tower for waste oil rerefining process.** O'Blasny, R.H.; Sparks, T.F.; Tierney, T.J.; Hunter, J.S. (to Vacsol Corp.). US Patent 4,140,212. 20 Feb 1979. Filed date 19 Aug 1977. 12p.

A simplified, essentially maintenance-free yet highly efficient distillation tower and method for waste oil rerefining is provided which allows direct vacuum distillation of additive-supplemented waste oils without chemical pretreatment thereof and yields a highly refined intermediate oil suitable for immediate use or final polishing, along with a valuable bottoms fraction usable in greases or asphalts, for example. The tower includes an upright, cylindrical chamber with a tangential waste oil inlet and cooperating internal baffle for creating a whirling oil flow pattern therewithin, along with means for maintaining the proper temperature conditions within the tower for maximizing vaporization and recovery of hydrocarbons from the waste oil while also preventing undesirable decomposition or cracking of the oil. In preferred forms, temperature maintenance is effected by heating the walls of the tower through the use of heating tape or plate coils; however, this same result can be achieved by flooding the tower with an excess of waste oil whereby the chamber is heated by the presence of the excess hot oil. The tower also preferably includes an apertured partition dividing the chamber into adjacent subchambers, along with a pressure-equalizing conduit in communication with the respective subchambers; this construction facilitates rapid and effective separation of the tower bottoms during processing. 5 figures, 7 claims.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 2435, 3660, 3661

2504 (AD-A—063188) **Investigation of extreme weather oil pollution response capabilities. Final report 14 November 1977-14 July 1978.** Beach, R.L.; March, F.A.; Ruetenik, G.W.; Davis, N.B. (Seaward International, Inc., Falls Church, VA (USA)). 15 Sep 1978. Contract DOT-CG-80372-A. 165p. NTIS PC A08/MF A01.

This report presents the results of a study to evaluate the state-of-the-art and determine the feasibility of attaining an extreme weather, pollution response capability. Sea states between 4 and 6 were considered. Investigations were made of systems for responding to stranding incidents, where the oil is still contained in a tanker, and for responding to oil spills. In the first case, cargo jettisoning and tanker stabilization methods were recommended as supplemental response techniques in addition to existing off-loading capabilities. In the second case, dispersant application from vessels and aircraft, and skimming with large (over 160 feet), dedicated skimming vessels, were recommended. Aircraft dispersant methods would provide response capabilities in sea state 6, and dedicated skimmers could work in sea state 5. The best existing skimming system is probably the Coast Guard's skimming barrier, which would be marginal in sea state 4. (Author)

2505 (DOE/EV—0046(Vol.2), pp 493-514) **Environmental assessment of treated versus untreated oil spills.** Wilson, M.P. Jr. (Univ. of Rhode Island, Kingston); Cece, J.M. Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

The decision to treat or not to treat an oil spill with dispersants under various conditions to mitigate the environmental impact of the spill and to protect the shoreline amenities involves a multiplicity of biological, chemical, physical, and meteorological inputs. Knowledge concerning the fate of treated and untreated spills is a prerequisite for estimating these environmental impacts. Biological data concerning acute and sub-acute concentrations and the temporal, spatial interrelationships of the affected marine biota must be understood and quantified as well as weathering of the oil, the modification of it by microorganisms, and the change in the chemical and physical nature of the oil caused by the use of dispersants. Most of the information to conduct such an assessment is not presently available, and must be obtained from a series of laboratory, meso-scale, and in-situ type of experiments. Impacts on marine organisms are based on predicted and observed exposures as experienced throughout the history of a spill. This has necessitated a relatively new approach in testing the response of marine organisms subjected to stresses, and modeled with respect to temporal, spatial, and chemical character of the stress as it might occur in the field. Early results indicate the method is tractable, and yields much more insight and perhaps different conclusions than would otherwise be obtained using standard methods.

2506 **Onshore impacts of offshore oil: a user's guide to assessment methods.** Williams, D.C.; Hom, K.B. Washington, DC; Dept. of The Interior (1979). 68p. (NP—24091). GPO.

This User's Guide discusses three principal methodologies for assessing and planning for the onshore impacts of offshore oil: (1) NERBC - onshore facilities related to offshore oil and gas development; (2) Weston - methodology for assessing onshore impact of offshore outer continental shelf oil and gas development; and (3) CF - environmentl planning for offshore oil and gas. Other relevant planning and impact methods, primarily state-developed, are also discussed. (DLC)

POLICY, LEGISLATION, AND REGULATION

REFER ALSO TO CITATION(S) 2695

TRANSPORT, PIPELINES, AND HANDLING

REFER ALSO TO CITATION(S) 2679

PROPERTIES

2507 (BETC—1778-4) **Stability survey of hydrocarbon fuels. Final report.** Bowden, J.N. (Southwest Research Inst., San Antonio, TX (USA). Mobile Energy Div.). Oct 1979. Contract EW-78-C-03-1778. 35p. Dep. NTIS, PC A03/MF A01.

A program to evaluate the storage stability characteristics of commercial and military fuels was conducted to establish a current reference base. Samples of No. 2 diesel fuels, JP-4 turbine fuels, unleaded, and leaded gasolines were obtained from ten military bases

across the continental United States. The samples were obtained in five-gallon cans from the final dispensing point at the bases, with the exception of the leaded gasolines. These gasolines were, in most cases, purchased at a service station off base. The samples are representative of commercial as well as military fuel currently in use in this country. Each sample was evaluated for physical properties and elemental analysis. The 43.3°C storage stability test, which included gum determinations after periods of 4, 8, 16 and 32 weeks, was conducted on all samples. The thermal stability of the JP-4 fuels was also measured. Results indicate that the JP-4 fuels are the most stable, followed by the unleaded gasolines, leaded gasolines, and the diesel fuels are the least stable. None of the jet fuels showed any degree of deterioration during the 32 weeks of storage, while at least one of each type of gasolines and four diesel fuels appeared to have some measure of unstability. 5 figures, 9 tables.

2508 (DOE/BC/30101—5) **Characterization of high boiling fossil fuel distillates via ^{1}H and ^{13}C NMR analysis. Final report, July 1, 1978-June 30, 1979.** Berlin, K.D.; O'Donnell, D.J.; Sigle, S.; Sturm, G.P. Jr. (Oklahoma State Univ., Stillwater (USA). Dept. of Chemistry; Department of Energy, Bartlesville, OK (USA). Bartlesville Energy Technology Center). Sep 1979. Contract EW-78-S-19-0001-001. 99p. Dep. NTIS, PC A05/MF A01.

High-boiling (535 to 675°C) distillates of Wilmington (Calif., USA) and Gach Saran (Iran) crude oils were separated into saturate, monoaromatic, diaromatic and polyaromatic-polar adsorption fractions by a silica gel-alumina dual packed gel chromatography column. These fractions were further separated on the basis of molecular volume by gel-permeation chromatography (GPC). All chromatographic separations were done by the Bartlesville Energy Technology Center of the DOE. Samples selected by the DOE were then analyzed by ^{13}C and ^{1}H NMR spectroscopy. The per cent fraction of aromatic carbons (Ar-C) of the total carbon content of a given series of GPC fractions obtained directly from the ^{13}C NMR spectra showed a significant range of values (e.g. 13.2% to 29.2%) within each series. Furthermore, the values of Ar-C within a series of GPC fractions showed a maximum in each case. No corresponding maximum was observed in the ^{1}H NMR spectra for the per cent fraction of aromatic proton (Ar-H) content compared to the total proton content in any of the GPC fraction series. Signals observed in the ^{13}C NMR spectra confirmed the presence of aliphatic chains attached to aromatic structures in the monoaromatic, diaromatic and polyaromatic-polar GPC series of each distillate. Well defined signals not attributable to straight-chain aliphatic material were also observed in the ^{13}C NMR spectra. Comparison of the ^{13}C NMR signals with those spectra of model compounds obtained experimentally and with the spectra of appropriate systems in the literature strongly suggested the presence of saturated terpenoid-like structures, as well as the presence of methyl groups in sterically hindered positions on an aromatic ring system.

2509 **Lubricating oil.** Papay, A.G. (to Edwin Cooper, Inc.). US Patent 4,158,633. 19 Jun 1979. Filed date 30 Mar 1978. 6p.

Engine crankcase lubricating oil containing a dihydrocarbyl hydrocarbylphosphonate (e.g. dimethyl octadecylphosphonate) exhibits reduced friction which results in an increase in gasoline mileage thus conserving energy. 3 tables, 9 claims.

2510 **Low pour hydrocarbon oil compositions.** Broeckx, W.P.; Dulog, L.G. (to S.A. Texaco Belgium N.V.). US Patent 4,142,865. 6 Mar 1979. Filed date 14 Oct 1977. 8p.

Low pour point hydrocarbon oil compositions are prepared by incorporating in a hydrocarbon oil such as crude oil, gas oil, residual fuel oil, etc. about 0.01 to about 0.5 percent by weight of an oil-soluble alkylated polybenzyl polymer or copolymer with, for example styrene, the said polymer or copolymer having a molecular weight of about 500 to about 50,000 or more. The polymer or copolymer may be added, for example, as a hydrocarbon solution to the base hydrocarbon oil after which the final oil composition is formed by heating the components to 100° to 350°F. for one hour or more with mixing. 10 claims.

COMBUSTION

REFER ALSO TO CITATION(S) 2457, 2468, 2939

NATURAL GAS

RESERVES

REFER ALSO TO CITATION(S) 2485

GEOLOGY AND EXPLORATION

REFER ALSO TO CITATION(S) 3495

2511 (INKA-Conf—79-080-004) **Future of hydrocarbon exploration.** Hotz, E. (Ruhrkohle A.G., Essen (Germany, F.R.)). 1979. 2p. (In German). (CONF-7904110—2). Dep. NTIS (US Sales Only), PC A02/MF A01.

From 2. symposium on the mineral resources potential of the earth; Hannover, F.R. Germany (18 Apr 1979).

2512 (METC/EGSP—12) **Structure contour map on top of the Middle Devonian Onondaga Group in western and northern Pennsylvania.** Harper, J.A.; Piotrowski, R.G. (Pennsylvania Dept. of Environmental Resources, Harrisburg (USA)). 1979. Contract EY-76-S-05-5198. 58p. Dep. NTIS, PC A04/MF A01.

Three maps are included. (DLC)

2513 (METC/SP—79/6, pp 485-498) **Fabric-element based classification for low-porosity-shale gas reservoirs.** Nuhfer, E.B.; Vinopal, R.J. (West Virginia Geological Survey, Morgantown). 1979.

From 3. Eastern gas shales symposium; Morgantown, WV, USA (1 Oct 1979).

Six lithotypes based on fabric elements are defined in Devonian shale of West Virginia: sharply banded shale; thinly laminated shale; lenticularly laminated shale; nonbanded shale; siltstones; and concretions. A traditional series exists from thinly laminated through lenticularly laminated to nonbanded. Thinly laminated and organic-rich lenticularly laminated shales appear the most favorable types for gas productivity because the laminated fabric permits the best lateral continuity of the low porosity (about 2%) present. The higher organic content of these lithotypes also probably acts as sites for significant sorption of gas, which is slowly released during production. No microfracture system appears to exist, and macroscopic fractures do not necessarily coincide with productive zones. Wells without natural fractures prove productive after stimulation, which suggests that outgassing of a favorable rock type is responsible for the bulk of productive gas in Devonian shale wells. Natural fracture porosity, while important in extending effective volume tapped by a given well, represents only a minor portion of reservoir storage volume. Thinly-laminated shales are interpreted as being generally representative of shallow-marine deposits (dominantly shelf deposits) accumulating under anoxic conditions. Nonbanded and lenticularly laminated shales are deeper water accumulations deposited further from shore. Sharply banded shales and some siltstones generally represent pulses of more rapid sedimentation in the prodelta environment. A single sample in itself is not diagnostic of depositional environment, but relative abundance of specific lithotypes in a given vertical section is useful for general environmental reconstruction. Better definition of the diagnostic worth of shale fabric-element lithotypes awaits results of more detailed fabric-element studies of modern fine grained clastics and marine muds. 8 figures.

2514 (ORO—5197-12) **Study of hydrocarbon: shale interaction. Annual report No. 2, October 1, 1977-September 30, 1978.** Schettler, P.D. Jr. (Juniata Coll., Huntingdon, PA (USA)). 1978. Contract EY-76-S-05-5197. 15p. Dep. NTIS, PC A02/MF A01.

The following data are presented for shales from wells in Ohio and New York: density, isotherm slope (volume of gas sorbed), BET area, specific degasibility, and porosity. (DLC)

DRILLING, PRODUCTION, AND PROCESSING

REFER ALSO TO CITATION(S) 2380, 2440, 2495

2515 (DOE/EIA—0103/6) **Monthly forecast of natural gas production in the United States for 1978. Technical Memorandum TM/ES/78-07.** Uri, N.; Flanagan, S. (Department of Energy, Washington, DC (USA). Energy Information Administration). Feb 1979. 52p. NTIS MF A01.

This report provides forecasts of natural gas production by state for 1978 on a monthly basis. The method is based on Box-Jenkins time series analysis. Results indicate that for the entire United States the production in 1978 will be 0.10% lower than the base period (September 1976-August 1977).

2516 (METC/SP—79/6, pp 211-223) **Pyrolysis of Eastern gas shale-effects of temperature and atmosphere on the production of light hydrocarbons.** Chou, M.I.M.; Dickerson, D.R. (Illinois State Geological Survey, Urbana). 1979.

From 3. Eastern gas shales symposium; Morgantown, WV, USA (1 Oct 1979).

Samples of black shales from four cores of the New Albany Shale Group (Devonian-Mississippian) from the Illinois Basin in Kentucky and Illinois were used in this study. Sections 4 inches long were taken from 4-inch diameter cores and were sealed in canisters

for study of released gas. Following study of released gas, the shale was crushed to < 100 mesh for use in the study of the effects of temperature and atmosphere on pyrolysis of shale. The correlation coefficients between the quantity of gas released at room temperature from the canistered core sections and the organic carbon content, and between the gas released and the total porosity of the shale samples were calculated for the individual cores. A study was made of the gaseous hydrocarbons produced by pyrolysis of shale at 600°C. Two regression lines could be drawn on the graph of the hydrocarbon gas produced versus the original organic carbon content, one ($r^2 = 0.96$) fitting data points for the Illinois cores and the other ($r^2 = 0.92$) fitting data points for the Kentucky core. The formation of alkanes was favored over that of alkenes, particularly at low temperature. Methane, ethane, and ethylene from thermal cracking and higher carbon number alkenes were positively identified in the gases from shale heated to above 120°C. A study was made of the effect of the pyrolysis atmosphere on the yield of light hydrocarbons (C_1 to C_6), carbon dioxide, carbon monoxide, acetaldehyde, and acetone during thermal degradation of a gram amount of selected shale samples. The yield of an individual hydrocarbon generally increased with the increase in the oxygen content of the pyrolysis atmosphere until the oxygen content reached the 10% level. The yield of carbon dioxide and carbon monoxide increased with the increase in oxygen content of the pyrolysis atmosphere.

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 2518, 2709

MARKETING AND ECONOMICS

REFER ALSO TO CITATION(S) 2500, 3298

ENVIRONMENTAL EFFECTS

REFER ALSO TO CITATION(S) 2435

2517 (DOE/EV—0046(Vol.2), pp 471-480) **Assessment of LNG release prevention and control.** Pelto, P.J.; Baker, E.G.; Hall, R.J. (Battelle Pacific Northwest Labs., Richland, WA). Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

Liquefied Natural Gas (LNG) operations have some potential for accidents resulting in public consequences. The safety of LNG facilities is dependent upon minimizing the frequency of occurrence and size of a potential release and minimizing the consequences of a release if it occurs. In this paper we examine the first factor, i.e., release prevention and control. The early results of an ongoing program sponsored by the Department of Energy Division of Environmental Control Technology are described.

2518 (DOE/EV—0046(Vol.2), pp 481-492) **LLL participation in LEF safety research.** Hogan, W.J. (Lawrence Livermore Lab., CA). Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

The Lawrence Livermore Laboratory has been asked by the Division of Environmental Control Technology of the DOE to develop and verify an ensemble of analytical models which can describe the phenomena occurring in LNG releases to the environment. The verification of the models will involve an extensive experimental program. The analytical and experimental program is described with emphasis on accomplishments to date. The ensemble of models is discussed and calculations are shown for differential boiloff, dispersion and vapor burn models. Preliminary results of 5 cubic meter spills of LNG on water, conducted at NWC in September 1978 are given. Plans for the large scale spill facility are summarized.

ARTIFICIAL STIMULATION, PLOWSHARE, ETC.

REFER ALSO TO CITATION(S) 2487, 2903

2519 (DOE/BG/01569—12) **Western Gas Sands Project. Status report, 1 July-31 July, 1979.** Atkinson, C.H. (CER Corp., Las Vegas, NV (USA)). 1979. Contract AC08-79BG01569. 74p. Dep. NTIS, PC A04/MF A01.

National Laboratories and Energy Technology Centers continued projects during July. Bartlesville Energy Technology Center continued work on core/fluid testing, fabrication of and improvements to confining pressure apparatus, advanced logging techniques and interpretation and reservoir simulation studies. At Lawrence Livermore Laboratory theoretical analysis and experimental programs continued for hydraulic fracturing. Testing of the borehole seismic and hydrophone systems for fracture mapping continued at Sandia Laboratories. The CER Corporation RB-MHF 3 well has been transferred to Rio Blanco Natural Gas Company for further testing. Cyclic gas injection and production continued at CIG's Miller No. 1 and Sprague No. 1 wells. The DOE well test facility was transported to the Rio Blanco Natural Gas Company well No. 397-19-1 Government. The cumulative production of Mitchell Energy Muse-Duke No. 1 as of July 31, 1979, was just over one billion cubic ft of gas. A flow log was run on the Mobil PCU F31-13G well. Exploratory coring for the Sandia Hole No. 6 fracture experiment continued in July with the completion of two additional holes.

2520 (METC/CR—79/17) **Massive hydraulic fracturing experiments of the Devonian shale in Lincoln County, West Virginia.** Cremean, S.P.; Forrest, R.M.; McKetta, S.F.; Morse, W.F.; Owens, G.L.; Smith, E.C. (Columbia Gas System Service Corp., Columbus, OH (USA)). Sep 1979. Contract EY-76-C-21-8014. 103p. Dep. NTIS, PC A06/MF A01.

The following preliminary conclusions were reached: Shale Stimulation Treatments - Hydraulically fractured wells will produce considerably more gas than wells stimulated with 80% gelled nitroglycerine. From a cost standpoint, the results suggest a single limited entry treatment in selected intervals is the preferred stimulation approach. The lower black shales contain significant producible gas. Large treatment sizes don't necessarily increase production proportionately and may cause extensive clean-up problems. Massive hydraulic fracturing may create economic gas production from undepleted Devonian shale areas near the test area. Devonian Shale Characterization - Mobile gas is mostly in the black or dark brown organic rich zones high in kerogen and uranium. Gamma ray and density logs can adequately locate these zones. Drilling and fracturing fluids do not affect the organic rich black Devonian shale; however, they do affect some gray shales. Rock properties show that the black shales fracture more easily than gray shales. The amount of potentially recoverable Devonian shale gas estimated by various methods ranges from 200 to 900 Tcf. The bulk of the recoverable shale gas appears to be adsorbed on the kerogen within the shale matrix. Devonian Shale Well Testing - Cumulative production curves on a log-log plot seem to provide the most reliable index of a well's long-term potential in this area. Normal reservoir pressure tests provide little useful data on hydraulically fractured shale wells. Because of potential damage related to fluid-formation interaction, excessive shut-in times required for testing could be detrimental if production is from fractures in the gray shales.

2521 (METC/SP—79/4) **Semi-annual report for the unconventional gas recovery program. Volume I, covering period ending September 1978.** Atkinson, C.H.; Wise, R.L. (Department of Energy, Morgantown, WV (USA). Morgantown Energy Technology Center). 1978. 232p. Dep. NTIS, PC A15/MF A01.

The following three projects are reported: methane recovery from coalbeds, eastern gas shales, and western gas sands. (DLC)

2522 (METC/SP—79/6, pp 225-246) **Theoretical and experimental analyses of hydraulic fracturing.** Anderson, G.D.; Hanson, M.E.; Shaffer, R.J. (Lawrence Livermore Lab., CA). 1979.

From 3. Eastern gas shales symposium; Morgantown, WV, USA (1 Oct 1979).

Experiments are being performed to study growth of hydraulically driven cracks in the vicinity of an unbonded interface in rocks. Blocks of rock materials which are to be studied are held adjacent to one another in a hydraulic press so that a normal stress is set up across their mutual interface. A hydraulically driven crack is initiated in one of the blocks. It is found that the major parameters which affect hydraulic crack penetration into the adjacent block are the relative values of the mechanical strength and moduli of the rocks on either side of the interface, the finish of the interface surfaces, and the magnitude of the normal stress across the interface. Experiments are being performed to study the frictional properties of interface surfaces. The experiments involve the simultaneous measurement of the normal force across the interface and the applied force necessary to overcome friction to initiate displacement. In addition to the normal force, the frictional force depends upon the surface finish and the presence of water in the rock. Newly developed numerical models have been applied to analyze some aspects of fracture propagation near well bonded material interfaces. Results from these calculations indicate that, for fractures propagating from a lower modulus material toward an interface with a higher modulus material, the stress intensity factor at the tip near the interface decreases significantly as the tip approaches the interface. However, upon penetration of the interfaces into the higher modulus material, the stress intensity factor is seen to increase abruptly and arrive at a higher value than in the lower modulus material. Conversely, when the fracture is propagating from a lower modulus material toward a higher modulus material, the situation is reversed. The presence of

existing fractures near the interface is seen to significantly reduce the effects of these phenomena. 15 figures, 2 tables.

2523 (ORO—5200-9) **Quarterly technical progress report, October 1, 1978-December 31, 1978.** (Ohio Dept. of Natural Resources, Columbus (USA)). 1978. Contract EY-76-S-05-5200. 17p. Dep. NTIS, PC A02/MF A01.

Progress is reported on resource inventory and on shale characterization in this part of the EGSP project (Eastern Gas Shale Project). (DLC)

POLICY, LEGISLATION, AND REGULATION

2524 **Recent developments in regulations for LNG storage in the United States.** Anderson, P.J. Chicago, IL; Institute of Gas Technology (1979). 60p. (CONF-790985—1). The Publisher, 3424 South State St., Chicago, IL 60616.

From Seminar on design and construction of LNG and LPG storage; Bethioua, Algeria (Sep 1979).

This paper considers sections of NFPA Standard 59A and proposed MTB regulations under Part 193 relating to LNG storage. Specifically, differences in the 1975 and 1979 editions of NFPA Standard 59A and the regulations in the NPR issued by MTB on February 8 are considered. Only those portions of the regulations dealing with the design and construction of metal tanks and impoundment design and capacity are covered, excluding the design aspects for metal tanks related to seismicity.

TRANSPORT, PIPELINES, AND HANDLING

2525 **Thermal barrier system for liquefied gas tank.** Androulakis, J.G. (to Frigitemp Corp.). US Patent 4,140,073. 20 Feb 1979. Filed date 12 Jul 1977. 6p.

Heat barrier components and improved thermal insulation techniques are provided for an external tank insulation system of ships carrying liquefied natural gas, propane, ammonia, etc. Reduction of liquid boil-off rate or initial cost of insulation through the reduction of radiant heat leak is accomplished by a composite insulation system includinng a high reflectance component material on the external surface of insulation and/or interior surface of the ship facing the tank. Further, refrigeration in tank boil-off is used to cool a radiation shield located between the tank insulation and surrounding enclosure, and to cool the skirt support. 13 figures.

PROPERTIES

REFER ALSO TO CITATION(S) 2709

2526 (ORO—5205-T3) **Characterization and analysis of Devonian shales as related to release of gaseous hydrocarbons. Well R-109, Washington County, Ohio.** Kalyoncu, R.S.; Boyer, J.P.; Snyder, M.J. (Battelle Columbus Labs., OH (USA)). 20 Jun 1979. Contract EY-76-C-05-5205. 133p. Dep. NTIS, PC A07/MF A01.

Coring of Well R-109 (Washington County, Ohio) was accomplished in August 1976. A total of 25 samples were collected. Hydrocarbon gas analyses indicate that higher chain hydrocarbon gases (C_2-C_6) make up a significant portion of total hydrocarbons in the shales, but methane is still the dominant single gas. Distinct relationships exist between the carbon and hydrocarbon gas contents, showing increase in hydrocarbon gas contents with increasing carbon. Similar relationships between hydrogen and hydrocarbon gas contents exist, though they are not as pronounced. Gas contents appear not to be related to the bulk densities in any quantitative manner, though organic contents (carbon and hydrogen) seem to be related to bulk density values much more clearly. R-109 shales are virtually impermeable to gases and other fluids, as attempted helium gas permeability measurements indicated extremely small ($< 10^{-12}$ Darcy) permeability values.

2527 (ORO—5205-T7) **Characterization and analysis of Devonian shales as related to release of gaseous hydrocarbons.** Kalyoncu, R.S.; Boyer, J.P.; Snyder, M.J. (Battelle Columbus Labs., OH (USA)). Oct 1979. Contract EY-76-C-05-5205. 124p. Dep. NTIS, PC A06/MF A01.

Physical, chemical, and lithological characterizations of the 0-3 well were made along with free gas analyses. Hydrocarbon gases made up 3 to 46.5% of the gas mixture surrounding the shale in the sealed canister which represents a hydrocarbon gas content of about 0.3 cubic foot per cubic foot of shale. Significant amounts of carbon found in the solid shales agree with the reasonably high gas contents. Familiar one-to-one relationships which have been observed in a number of previous wells are also apparent for the 0-3 well.

COMBUSTION

REFER ALSO TO CITATION(S) 2709

STORAGE

REFER ALSO TO CITATION(S) 2524

2528 (ANL/EES-TM—62) **Maximizing natural gas storage levels: an assessment of the costs and benefits.** Walbridge, E.W.; Chambers, W.C.; Kaufman, H.A.; Shrivastiva, V.K.; South, D.W.; Ng, N.K.; Morris, J.R. (Argonne National Lab., IL (USA)). Sep 1978. Contract W-31-109-ENG-38. 61p. Dep. NTIS, PC A04/MF A01.

This report is an assessment of the maximizing of storage levels of the reservoirs owned by interstate natural gas pipeline companies. It is envisaged that it may be desirable for the federal government to foster such maximization in anticipation of a cold winter. The assessment involves estimating how much additional interstate gas would be in storage on November 1, 1979 as a result of the maximization, estimating the economic, environmental, and social impacts of the additional gas, and estimating impacts on the interstate pipeline companies. The additional gas volumes and the economic and environmental impacts are determined for each state. The states having the highest additional gas volumes due to maximization and the greatest benefits stemming therefrom are Pennsylvania, Ohio, New York, Michigan, and Illinois.

2529 **Method of storing liquefied gases at low temperature in a subterranean cavity.** Boulanger, A. (to Societe Francaise de Stockage Geologique Geostock). US Patent 4,140,423. 20 Feb 1979. Priority date 2 Dec 1976, France, 8p.

During the process of cooling, the stresses in the earth pass first through a maximum compression and then this gives place to traction up to the moment when fissures appear. The application of cooling is conducted so as to reduce the size of these fissures and to prevent their propagation through the compressed zone. They are plugged preferably by spraying water in the course of application of cooling. 1 figure, 12 claims.

OIL SHALES AND TAR SANDS

SITE GEOLOGY

REFER ALSO TO CITATION(S) 2514, 2516

DRILLING, FRACTURING, AND MINING

REFER ALSO TO CITATION(S) 2533

OIL PRODUCTION, RECOVERY, AND REFINING

REFER ALSO TO CITATION(S) 2710

IN SITU METHODS, TRUE AND MODIFIED

REFER ALSO TO CITATION(S) 2903

2530 (DOE/EV—0046(Vol.1), pp 292-307) **Integrated compliance and control technology research activities for in situ fossil fuel processing experiments.** Farrier, D.S.; Harrington, L.W.; Poulson, R.E. (Dept. of Energy, Laramie, WY). Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

Fossil fuel processing research facilities must comply with Federal and state regulatory standards. In addition, the experimental sites provide research opportunities to evaluate control needs and then design and demonstrate control measures as each technology approaches commercialization. This paper summarizes the regulatory compliance and control technology activities and illustrates their integration as pertaining to field in situ recovery experiments for oil shale.

2531 (DOE/EV—0046(Vol.1), pp 323-333) **Strategy for the abandonment of modified in-situ oil shale retorts.** Fox, J.P. (Lawrence Berkeley Lab., CA); Persoff, P.; Moody, M.M.; Sisemore, C.J. Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

Burned out oil shale retorts need to be stabilized to prevent subsidence of the overburden and the ground surface; prevent gas leakage; maximize resource utilization; and provide subsurface disposal of spent shale that has been retorted on the surface and minimize ground water contamination. In order to stabilize the retorts, the following strategy should be followed. (1) Characterize the components of the retort such as overburden and pillar strength; temperature effect on strength; retort and pillar permeability; and rubble behavior during and after retorting. (2) Develop slurry that can accommodate a maximum amount of spent shale and low quality water. (3) Investigate techniques for emplacing the grout and sealing the retorts. (4) Develop a retort cooling process whereby sensible heat can be recovered and the residual rubble will have properties amenable to grouting. (5) Prepare a full scale field test program to evaluate the optimum combination of cooling procedures, grout and emplacement techniques.

2532 (LETC/RI—79/7) **Simulated in situ retorting of oil shale in a controlled-state retort. I. Nitrogen atmosphere, interrupted runs.** Duvall, J.J. (Department of Energy, Laramie, WY (USA). Laramie Energy Technology Center). Sep 1979. 64p. Dep. NTIS, PC A04/MF A01.

A series of experiments has been performed on Green River oil shale using the controlled-state retort, an electrically heated retort designed to simulate in situ retorting. Each experiment described was stopped when only part of the shale bed had been completely retorted. Retorting parameters investigated include heating rate, retorting advance rate, gas input flow rate, and maximum temperature. Oils were washed and bitumens were extracted from the partially retorted and unretorted oil shales. The oils and bitumens were examined by simulated distillation gas chromatography, the product gases were analyzed by mass spectroscopy, and the shales were subjected to elemental analysis. Results of the various analyses are presented and conclusions are drawn from the data concerning the way the product oil moves through the bed of unretorted shale. The effects of temperature, heating rate, gas flow rate, and breadth of retorting zone on oil film thickness and bitumen content; the effect of heating rate on organic carbon content in the retorted shale; and the effect breadth of retorting zone has on the boiling point distribution of oils and bitumens as related to distance from the retorting zone are discussed.

2533 (SAND—79-1789) **Oil shale programs. Fourteenth quarterly report, April-June, 1979.** Stevens, A.L. (ed.). (Sandia Labs., Albuquerque, NM (USA)). Sep 1979. Contract EY-76-C-04-0789. 38p. Dep. NTIS, PC A03/MF A01.

The work is being performed under three programs: (1) Diagnostics and Rock Mechanics Support for the LETC in-situ Oil Shale Program; (2) Advanced Instrumentation and Field Projects for in-situ Oil Shale Processing; and (3) In-situ Bed Preparation Study. Two unsuccessful attempts were made to ignite and retort the Well 2 to Well W two-well pattern within the main wellborne pattern at Rock Springs Site 12. A third ignition was attempted in Well V which was in a region of more extensively fractured shale; combustion was sustained for about 94 hours. On the Geokinetics Oil Shale Project, the Retort 20 was blasted on April 6, and the explosive rubbling of Retorts 21 and 22 was completed on June 27. Work on the In Situ Retorting Model (Crack Model) included modifications and improvements to the code, use of the code to evaluate various retort designs, and continuation of small scale block retorting studies in the laboratory. The code has been used this quarter to evaluate two retort designs; the study of the effect of borehole spacing on an in situ borehole retort is discussed. Calculations have been conducted to determine the distance (or burden) of an explosive charge from a free face which optimizes the extent of fragmentation; the results show that there is an optimum depth of the explosive below the surface that maximizes the rock removed for a given charge size. Laboratory fragmentation tests indicate that fragment size varies inversely with strain rate with a power law relationship. (DLC)

2534 (UCRL—83568) **Studies of oil-shale reaction chemistry at LLL.** Burnham, A.K. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1 Nov 1979. Contract W-7405-ENG-48. 39p. (CONF-791209—1). Dep. NTIS, PC A03/MF A01.

From Institute of Gas Technology symposium; Atlanta, GA, USA (3 Dec 1979).

A review is presented of recent studies on the chemistry of oil shale retorting. Kinetics are summarized for oil production and destruction mechanisms including kerogen-bitumen pyrolysis, oil coking and oil cracking. The effect of retorting conditions on shale oil quality is discussed along with the reverse process of inferring retorting conditions and yield loss mechanisms in modified in-situ retorts. Kinetic studies of carbonate mineral decomposition and related mineral reactions as well as residual carbon gasification are outlined.

2535 **Process for recovering shale oil.** Larson, O.A.; Matthews, C.W. (to Gulf Oil Corp.). US Patent 4,158,467. 19 Jun 1979. Filed date 30 Dec 1977. 10p.

An improved process for recovering shale oil from in-situ shale comprising the steps of: (1) mining a first portion of said shale; (2) fragmenting a second portion of said shale; (3) introducing into said second portion a mixture of gases comprising a molecular oxygen supplying gas, carbon dioxide and hydrogen sulfide while maintaining a temperature sufficient to convert kerogen in said second portion to shale oil and to produce carbon dioxide, hydrogen sulfide, gaseous hydrocarbons and other combustion and inert gases; (4) separating said shale oil from an offgas containing said carbon dioxide, hydrogen sulfide, gaseous hydrocarbons and other combustion and inert gases; (5) separating hydrogen sulfide and a first portion of carbon dioxide from a gas of low sulfur content and increased heating value comprising said gaseous hydrocarbons and other combustion and inert gases and a second portion of said carbon dioxide; and (6) recycling said hydrogen sulfide and said first portion of said carbon dioxide to step (3). 13 claims.

2536 (SAND—79-0522(Vol.5)(No.1), pp 18-25) **Process research for energy extraction.** Traeger, R.K. May 1979.

In Sandia technology.

Process research is in progress on underground coal gasification, enhanced gas recovery, enhanced oil recovery, coal liquefaction, magma energy, and in-situ retorting of oil shale. Two examples are discussed in this paper: in-situ retorting of oil shale and coal liquefaction. (DLC)

SURFACE METHODS

2537 (DOE/EV—0046(Vol.1), pp 308-322) **Assessment of control technology for shale oil wastewaters.** Mercer, B.W.; Wakamiya, W.; Spencer, R.R.; Mason, M.J. (Battelle Pacific Northwest Labs., Richland, WA). Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

Wastewater disposal is an important element to be considered in evaluating the environmental impact of the developing shale oil industry. Wastewater can be generated by a number of different sources within a shale oil recovery facility, depending on the type of recovery system used, the location, and the type of oil shale processed. The pollution potential of the wastewater may be very high as in the case of retort water or it may be low as in the case of some minewaters. Studies have been completed on the evaluation of land disposal and underground injection as disposal options for shale oil wastewaters. Land disposal is the application of wastewater at the soil/air interface to utilize natural chemical and physical reactions for purifying the wastewater. Underground injection makes use of deep confined aquifers or isolated geological zones for discharge of wastewaters. The results of this investigation indicate that both the wastewater characteristics and the climate of the oil shale regions of Colorado, Utah, and Wyoming are not favorable for land disposal of retort water. Underground injection is a viable disposal option for retort water where geological conditions are favorable; however, regulatory restraints are expected to limit the use of this option. Studies are currently in progress on benchscale evaluations of treatment technology for retort water and mine water. Conventional biological treatment appears to be adversely affected by toxicants in the retort water, however, preliminary results indicate that the addition of powdered activated carbon may overcome this problem. Several different methods have been investigated for removal of fluoride, boron, and alkalinity from minewaters. Ion exchange is a leading candidate for treatment of minewaters.

2538 (PNL—2945) **Source characterization studies at the Paraho semiworks oil shale retort.** Fruchter, J.S.; Wilkerson, C.L.; Evans, J.C.; Sanders, R.W.; Abel, K.W. (Battelle Pacific Northwest Labs., Richland, WA (USA)). May 1979. Contract EY-76-C-06-1830. 171p. Dep. NTIS, PC A08/MF A01.

In order to determine the redistribution of trace and major elements and species during aboveground oil shale retorting, a comprehensive program was carried out for the sampling and analysis of feedstock, products, effluents, and ambient particulates from the Paraho Semiworks Retort. Samples were obtained during two periods in 1977 when the retort was operating in the direct mode. The data were used to construct mass balances for 31 trace and major elements in various effluents, including the offgas. The computed mass balances indicated that ~ 1% or greater fractions of the As, Co, Hg, N, Ni, S, and Se were released during retorting and redistributed to the product oil, retort water, or product offgas. The fraction released for these seven elements ranged from ~ 1% for Co and Ni to 50 to 60% for Hg and N. Approximately 20% of the S and 5% each of the As and Se were released. Ambient aerosols were found to be elevated near the retorting facility and associated crushing and retorted shale disposal sites. Approximately 50% of these particles were in the respirable range (< 5 μm). The elevated dust loadings are presented very local, as indicated by relatively low aerosol loadings at background sites 100 to 200 m away. State-of-the-art dust control measures were not employed. 15 figures, 19 tables.

2539 (UCID—18282) **Oil shale project small retort run summary, run S-15.** Ackerman, F.J.; Sandholtz, W.A.; Raley, J.H.; Mallon, R.G.; Carley, J.F.; Tripp, L.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Sep 1979. Contract W-7405-ENG-48. 67p. Dep. NTIS, PC A04/MF A01.

Run S-15, the third in a series of steam/air combustion runs, in the 125-kg retort, was identical to Runs S-13 and S-14 in input gas parameters. The principal difference among these runs was the size distribution of the raw shale charge: S-13, -2.5 + 1.3 cm; S-14, -7.6 + 0.001 cm; and S-15, -2.5 + 0.001 cm. Objective was to determine if lower oil yields and the flow nonuniformities evidenced by rough irregular axial temperature profiles in S-14 and L-1 were attributable primarily to the larger particles (+ 2.5 cm). Temperature profiles from previous runs on small uniform shale particles (e.g., S-13) were smooth and regular and oil yields were high (> 90% of Fischer assay). The run was straightforward and ran as predicted. Centerline bed temperatures averaged 1025°C, the highest yet observed in a 125-kg retort run. This produced some wrinkling of the 304 stainless steel retort vessel. Oil yield from S-15 was comparable to that of S-14 (86% vs 88% Fischer assay). The S-15 temperature profiles were as rough as those from S-14. Run S-15 to the conclusion that fines (< 1.3 cm) also contribute to flow nonuniformities, temperature excursions, and yield loss. One hypothesis is that packed fines with their low permeability (especially if they retain process liquids) divert flows as effectively as blocks. Hydrogen production in S-15, 0.38 wt % of raw shale, was the highest yet observed from LLL retorts. This is attributed mainly to the smaller particle size of the shale charge. Pockets of dark shale (unconsumed char) were observed in the lower portion of the bed when the spent shale was unloaded. Consistent with this was the delay, or even absence, of oxygen appearance in intra-retort gas sampled near these pockets. Thus, nonuniformities in gas flow were particularly evident in these regions.

PROPERTIES AND COMPOSITION

REFER ALSO TO CITATION(S) 2526

2540 **Cross polarization magic-angle spinning ^{13}C NMR spectra of oil shales.** Miknis, F.P. (Dept. of Energy, Laramie, WY); Maciel, G.E.; Bartuska, V.J. *Org. Geochem.;* **1**: No. 3, 169-176(Jul 1979).

Cross polarization magic-scale spinning ^{13}C NMR spectra have been obtained on oil shales representing a variety of geologic ages, origins, depositional environments, and source locations. The spectra show variations in the aliphatic and aromatic carbon distributions of the oil shales and reveal correlations between aliphatic carbon contents and potential shale oil yields. Hints of additional fine structure are present in the spectra of some samples, and examples are given of the spectral resolution that may be obtainable on other solid samples of geochemical interest.

2541 **Analytical chemistry of liquid fuel sources: tar sands, oil shale, coal, and petroleum. Chapter 16. Olefin analysis in shale oils.** Jackson, L.P.; Allbright, C.S.; Poulson, R.E. Washington, DC; American Chemical Society (1978). 11p. (NP—24063).

The classical silica gel chromatographic method for determination of percent olefins in shale oils was studied and found wanting, mainly because of cross-contamination from high levels of olefins and heteroatom-containing compounds. This paper describes a new hydroboration/oxidation procedure for olefins, and reports its use in hydrocarbon-type analysis of both whole shale oils and distillate fractions. Percent composition values for three whole oils ranged as follows: saturates, 13 to 26; olefins, 16 to 20; aromatics, 5 to 14; polar compounds, 41 to 62. A discussion of ir analysis for relative amounts of specific olefin types such as terminal, internal trans, and methylene structures is included.

DIRECT USES AND BY-PRODUCTS

2542 **Coal analyses and lithologic descriptions of five core holes drilled in the carbon basin of southcentral Wyoming.** Glass, G.B. Laramie, WY; Geological Survey (1978). 104p. (NP—24081). The Publisher, Box 3008, University Station, Laramie, WY 82071.

A total of 2,454.9 ft of 1.75- to 2-in. dia cores were recovered from five core holes. The analyses carried out, whose results are tabulated in this report, were for chemical composition, heat of combustion, sulfur form, ash fusion temperature, major and minor oxides, and trace elements. Lithologic descriptions, geophysical logs, and megascopic descriptions are included as appendices. 22 figures, 15 tables. (DLC)

HEALTH AND SAFETY

2543 (LA—8032-MS) **Air sampling at Paraho Oil Shale Operations.** Garcia, L.L.; Schulte, H.F. (Los Alamos Scientific Lab., NM (USA)). Sep 1979. Contract W-7405-ENG-36. 17p. Dep. NTIS, PC A02/MF A01.

This report provides information on worker exposures related to shale oil recovery and processing. Air sampling was limited to mining, crushing, and retorting processes. Major emphasis was placed on the above ground semiworks retort developed by Paraho Development Corporation because of the uniqueness of the process. Air sampling was conducted with direct reading instruments and by gravimetric analysis. Dust, gas, and vapor concentrations potentially hazardous to worker health were noted at most work areas. However, no personal samples were taken to evaluate individual exposures on any workers, therefore, values are indicative only of area concentrations and not personnel exposures. Due to the research nature of this Paraho retorting operation, the concentrations at the various areas would not be indicative of a commercial operation. However, sampling results indicate commercial operations will require control measures to limit worker exposures to acceptable levels. 15 figures, 7 tables.

MARKETING AND ECONOMICS

2544 **Model of the economic efficiency of the exploitation of oil shale in comparison with other mineral sources of energy.** Gurfel, B. (Ben-Gurion Univ of the Negev, Beer Sheva, Isr). *Appl. Energy;* **5**: No. 3, 205-213(Jul 1979).

A model is presented which is based on the following points: a source of energy raw materials is a production complex of an output, processing and utilisation of the reserves, and manufacture of by-products; each type of production has its own characteristics; Direct and feedback production links exist between the existing and newly created production capacities; the model is designed largely for energotechologic utilisation towards the production of essential energy products; it foresees a discrete variation of power capacity so that this nonlinear function of expense is taken into account; and it makes it possible to ground the rational structure and volume of oil shale use and to draw into production more from its enormous reserves.

ENVIROMENTAL ASPECTS

REFER ALSO TO CITATION(S) 2530, 2537

NUCLEAR FUELS

RESERVES

REFER ALSO TO CITATION(S) 2662

2545 (GJBX—141(79)) **Uranium deposits of the Grants, New Mexico mineral belt (II).** Brookins, D.G. (New Mexico Univ., Albuquerque (USA). Dept. of Geology). Jul 1979. Contract EY-76-C-13-1664. 425p. Dep. NTIS, PC A18/MF A01.

This is part of a study of the genesis of the U deposits of the Grants mineral belt. Enrichment of Mg in ore zones is frequently observed, with chlorite being a common product. Clay mineralogic studies argue for chlorite-illite-montmorillonite associations with ores. The methods include scanning electron microscopy, Eh-pH diagrams, activation analysis, and rare earth element studies. (DLC)

2546 (LA—8054-PR) **Oklo: natural fission reactor program. Progress report, April 1-June 30, 1979.** Norris, A.E. (Los Alamos Scientific Lab., NM (USA)). Sep 1979. Contract W-7405-ENG-36. 19p. (ONWI/Sub—79/E511-01100-7). Dep. NTIS, PC A02/MF A01.

Analyses of samples from the Oklo site have shown that ^{99}Tc and fissiogenic ruthenium appear to have migrated upwards with respect to the natural fission reactors. This migration was measured over distances of 2 to 10 meters from the reactor zones. The native material of the basal conglomerate was shown not to be a source of the radiogenic Pb incorporated in the stratum. Thus, the radiogenic Pb must have come from the Oklo uranium ore bodies. A sensitive technique was developed for mass spectrometric analyses of ruthenium at the nanogram level. Measurements with this technique permitted validation of a U-Ru age dating procedure by comparison with U-Pb dates from the same ores. Measured yields of ^{101}Ru, ^{102}Ru, and ^{104}Ru from spontaneous fission of ^{238}U were found to

agree with previous estimates. Analyses of two samples from the Morro do Ferro thorium deposit in Brazil cannot be used to define a precise time of ore formation. The data can be used to infer relative migration of thorium with respect to lead during the past 290 x 10^6 years. 2 figures, 5 tables.

EXPLORATION

2547 (GJBX—87(79)(Vol.2)) **Aerial radiometric and magnetic survey: Billings National Topographic Map, Montana.** (Geodata International, Inc., Dallas, TX (USA)). 1979. Contract EY-76-C-13-1664. 146p. Dep. NTIS, PC A07/MF A01.

Results from the aerial radiometric and magnetic survey are presented in the form of anomaly maps (^{208}Tl, ^{214}Bi, ^{40}K, ^{214}Bi/^{208}Tl, ^{214}Bi/^{40}K, ^{208}Tl/^{40}K), radiometric multiple parameter stacked profiles, and magnetic and ancillary stacked profile data. Flight base and geology maps are included.

2548 (GJBX—104(79)(Vol.1)) **Aerial radiometric and magnetic survey: Tonopah National Topographic Map, Nevada.** (Geodata International, Inc., Dallas, TX (USA)). 27 Apr 1979. Contract EY-76-C-13-1664. 221p. Dep. NTIS, PC E12/MF E12.

The results of analyses of the airborne gamma radiation and total magnetic field survey flown for the region identified as the Tonopah National Topographic Map NJ11-5 is presented in Volume I and II of this report. The airborne data gathered is reduced by ground computer facilities to yield profile plots of the basic uranium, thorium and potassium equivalent gamma radiation intensities, ratios of these intensities, aircraft altitude above the earth's surface, total gamma ray and earth's magnetic field intensity, correlated as a function of geologic units. The distribution of data within each geologic unit, for all surveyed map lines and tie lines, has been calculated and is included. Two sets of profiled data for each line are included with one set displaying the above-cited data. The second set includes only flight line magnetic field, temperature, pressure, altitude data plus magnetic field data as masured at a base station. A general description of the area, including descriptions of the various geologic units and the corresponding airborne data, is included also.

2549 (GJBX—112(79)) **Aerial gamma ray and magnetic survey: Gillette Detail Project, Wyoming. Final report. Volume I.** (GeoMetrics, Inc., Sunnyvale, CA (USA)). Jun 1979. Contract EY-76-C-13-1664. 58p. Dep. NTIS, PC E01/MF E01.

In the middle of August 1978, geoMetrics, Inc., collected 810 lines miles of high sensitivity airborne radiometric and magnetic data (1/4 x 1/4 mile grid) in northeast Wyoming over a small section of the Black Hills. All radiometric and magnetic data were fully reduced and interpreted by geoMetrics and are presented as two volumes (Volume I and II) in this final report. Major geologic structures within this portion of the Black Hills Uplift are the Tertiary alkaline intrusives of the topographically dominant Bear Lodge Mountains. Economic mineral deposits are not presently known, but thorium prospects do exist in the intrusives. The data were examined for anomalous uranium values and mappable geochemical subunits usng the radiometric and magnetic data. Three distinct subunits were derived based on the potassium and thorium windows. Fourteen groups of uranium samples qualified as anomalies based on area wide statistics. Most anomalies are associated with the Tertiary intrusives.

2550 (GJBX—136(79)(Vol.1)) **Aerial radiometric and magnetic survey: Vya National Topographic Map, Nevada.** (Geodata International, Inc., Dallas, TX (USA)). 1979. Contract EY-76-C-13-1664. 149p. Dep. NTIS PC E11/MF E11.

The results of analyses of the airborne gamma radiation and total magnetic field survey flown for the region identified as the Vya National Topographic Map NK11-7 is presented in Volume I and II of this report. The airborne data gathered is reduced by ground computer facilities to yield profile plots of the basic uranium, thorium and potassium equivalent gamma radiation intensities, ratios of these intensities, aircraft altitude above the earth's surface, total gamma ray and earth's magnetic field intensity, correlated as a function of geologic units. The distribution of data within each geologic unit, for all surveyed map lines and tie lines, has been calculated and is included. Two sets of profiled data for each line are included with one set displaying the above-cited data. The second set includes only flight line magnetic field, temperature, pressure, altitude data plus magnetic field data as measured at a base station. A general description of the area, including descriptions of the various geologic units and the corresponding airborne data, is included also.

2551 (GJBX—136(79)(Vol.2)) **Aerial radiometric and magnetic survey: Vya National Topographic Map, Nevada.** (Geodata International, Inc., Dallas, TX (USA)). 1979. Contract EY-76-C-13-1664. 158p. Dep. NTIS, PC A08/MF A01.

Anomaly maps, magnetic and ancillary stacked profile data, radiometric multiple-parameter stacked profiles, flight base map, and geology map are presented.

2552 (GJBX—137(79)(Vol.1)) **Aerial radiometric and magnetic survey: Wells National Topographic Map, Nevada.** (Geodata International, Inc., Dallas, TX (USA)). 1979. Contract EY-76-C-13-1664. 156p. Dep. NTIS PC E12/MF E12.

The results of analyses of the airborne gamma radiation and total magnetic field survey flown for the region identified as the Wells National Topographic Map NK11-9 is presented in Volume I and II of this report. The airborne data gathered is reduced by ground computer facilities to yield profile plots of the basic uranium, thorium and potassium equivalent gamma radiation intensities, ratios of these intensities, aircraft altitude above the earth's surface, total gamma ray and earth's magnetic field intensity, correlated as a function of geologic units. The distribution of data within each geologic unit, for all surveyed map lines and tie lines, has been calculated and is included. Two sets of profiled data for each line are included with one set displaying the above-cited data. The second set includes only flight line magnetic field, temperature, pressure, altitude data plus magnetic field data as measured at a base station. A general description of the area, including descriptions of the various geologic units and the corresponding airborne data, is included also.

2553 (GJBX—137(79)(Vol.2)) **Aerial radiometric and magnetic survey: Wells National Topographic Map, Nevada.** (Geodata International, Inc., Dallas, TX (USA)). 1979. Contract EY-76-C-13-1664. 146p. Dep. NTIS, PC A07/MF A01.

Results from the aerial radiometric and magnetic survey are presented as anomaly maps, magnetic and ancillary stacked profiles, radiometric multiple parameter stacked profiles, flight base map, and geology map.

2554 (GJBX—138(79)(Vol.1)) **Aerial radiometric and magnetic survey: Lemmon National Topographic Map, South Dakota.** (Geodata International, Inc., Dallas, TX (USA)). 1979. Contract EY-76-C-13-1664. 107p. Dep. NTIS, PC E08/MF E08.

The results of analyses of the airborne gamma radiation and total magnetic field survey flown for the region identified as the Lemmon National Topographic Map NL13-9 is presented in Volume I and II of this report. The airborne data gathered is reduced by ground computer facilities to yield profile plots of the basic uranium, thorium and potassium equivalent gamma radiation intensities, ratios of these intensities, aircraft altitude above the earth's surface, total gamma ray and earth's magnetic field intensity, correlated as a function of geologic units. The distribution of data within each geologic unit, for all surveyed map lines and tie lines, has been calculated and is included. Two sets of profiled data for each line are included with one set displaying the above-cited data. The second set includes only flight line magnetic field, temperature, pressure, altitude data plus magnetic field data as measured at a base station. A general description of the area, including descriptions of the various geologic units and the corresponding airborne data, is included also.

2555 (GJBX—138(79)(Vol.2)) **Aerial radiometric and magnetic survey: Lemmon National Topographic Map, South Dakota.** (Geodata International, Inc., Dallas, TX (USA)). 1979. Contract EY-76-C-13-1664. 130p. Dep. NTIS, PC A07/MF A01.

Results are presented in the form of radiometric multiple-parameter stacked profiles, magnetic and ancillary stacked profile data, anomaly maps, geology map, and flight base map.

2556 (GJBX—139(79)(Vol.1)) **Aerial radiometric and magnetic survey: Dickinson National Topographic Map, North Dakota.** (Geodata International, Inc., Dallas, TX (USA)). 1979. Contract EY-76-C-13-1664. 110p. Dep. NTIS, PC E08/MF E08.

The results of analyses of the airborne gamma radiation and total magnetic field survey flown for the region identified as the Dickinson National Topographic Map NL13-6 is presented in Volume I and II of this report. The airborne data gathered is reduced by ground computer facilities to yield profile plots of the basic uranium, thorium and potassium equivalent gamma radiation intensities, ratios of these intensities, aircraft altitude above the earth's surface, total gamma ray and earth's magnetic field intensity, correlated as a function of geologic units. The distribution of data within each geologic unit, for all surveyed map lines and tie lines, has been calculated and is included. Two sets of profiled data for each line are included with one set displaying the above-cited data. The second set includes only flight line magnetic field, temperature, pressure, altitude data plus magnetic field data as measured at a base station. A general description of the area, including descriptions of the various geologic units and the corresponding airborne data, is included also.

2557 (GJBX—140(79)) **Albany 1° x 2° NTMS area Connecticut, Massachusetts, New Hampshire, New York, and Vermont: data report.** Koller, G.R. (Du Pont de Nemours (E.I.) and Co., Aiken, SC

(USA). Savannah River Lab.). Aug 1979. Contract EY-76-C-13-1664. 352p. (DPST—79-146-10). Dep. NTIS, PC E07/MF E07.

Stream sediment and stream water samples were collected from small streams at 1328 sites. Ground water samples were collected at 664 sites. Neutron activation analysis (NAA) results are given for uranium and 16 other elements in sediments, and for uranium and 8 other elements in ground water and surface water.

2558 (GJBX—144(79)(Vol.2)) **Airborne gamma-ray spectrometer and magnetometer survey: Cortez Quadrangle (Colorado, Utah). Final report.** (Western Geophysical Co. of America, Houston, TX). Jul 1979. Contract EY-76-C-13-1664. 274p. Dep. NTIS, PC A12/MF A01.

Flight line profile data and statistical analysis results are presented.

2559 (GJBX—151(79)) **Hydrogeochemical and stream sediment reconnaissance basic data for Lubbock NTMS Quadrangle, Texas.** (Oak Ridge Gaseous Diffusion Plant, TN (USA)). 31 Aug 1979. Contract EY-76-C-13-1664. 197p. (K/UR—129). Dep. NTIS, PC A09/MF A01.

Field and laboratory data are presented for 994 groundwater and 602 stream sediment samples. Statistical and areal distributions of uranium and possible uranium-related variables are displayed. A generalized geologic map of the survey area is provided, and pertinent geologic factors which may be of significance in evaluating the potential for uranium mineralization are briefly discussed. Interpretation of the groundwater data indicate that the area which appears most promising for uranium mineralization is located in the southwestern part of the quadrangle, particularly in Crosby, Garza, Lynn, and Lubbock Counties. The waters produced from the Ogallala Formation in this area have high values for arsenic, molybdenum, selenium, and vanadium. Groundwaters from the Dockum Group in Garza County where uranium is associated with selenium, molybdenum, and copper indicate potential for uranium mineralization. Uranium is generally associated with copper, iron, and sulfate in the Permian aquifers reflecting the red bed evaporite lithology of those units. The stream sediment data indicate that the Dockum Group has the highest potential for uranium mineralization, particularly in and around Garza County. Associated elements indicate that uranium may occur in residual minerals or in hydrous manganese oxides. Sediment data also indicate that the Blaine Formation shows limited potential for small red bed copper-uranium deposits.

2560 (GJBX—153(79)(Vol.1)) **NURE aerial gamma-ray and magnetic reconnaissance survey: Colorado-Arizona area, Craig NK 13-10 Quadrangle. Volume I: narrative report.** (LKB Resources, Inc., Huntingdon Valley, PA (USA)). Sep 1979. Contract EY-76-C-13-1664. 136p. Dep. NTIS PC08/MF E08.

As part of the Department of Energy (DOE) National Uranium Resource Evaluation (NURE) Program, LKB Resources, Inc. has performed a rotary-wing, reconnaissance high sensitivity radiometric and magnetic survey in north-west Colorado. The 1:250,000 scale NTMS Craig quadrangle was surveyed. A total of 3,039 line miles of data were collected utilizing a Sikorsky S58T helicopter. Traverse lines were flown in an east-west direction at 3.0 mile spacing, with tie lines flown in a north-south direction at 12 mile spacing. The data were digitally recorded at 1.0 second intervals. The NaI terrestrial detectors used in this survey had a volume of 2,154 cubic inches. The magnetometer employed was a modified ASQ-10 fluxgate system. The radiometric data were normalized to 400 feet terrain clearance. The data are presented in the form of computer listings on microfiche and as stacked profile plots. Profile plots are contained in Volume II of this report. A geologic interpretation of the radiometric and magnetic data is included as part of this report.

2561 (GJBX—154(79)) **Aerial radiometric and magnetic survey: Millett National Topographic Map, Nevada.** (Geodata International, Inc., Dallas, TX (USA)). 1979. Contract EY-76-C-13-1664. 419p. Dep. NTIS, PC E11/MF E11.

The results of analyses of the airborne gamma radiation and total magnetic field survey flown for the region identified as the Millett National Topographic Map NJ11-2 are presented. The airborne data gathered are reduced by ground computer facilities to yield profile plots of the basic uranium, thorium and potassium equivalent gamma radiation intensities, ratios of these intensities, aircraft altitude above the earth's surface, total gamma ray and earth's magnetic field intensity, correlated as a function of geologic units. The distribution of data within each geologic unit, for all surveyed map lines and tie lines, has been calculated and is included. Two sets profiled data for each line are included, with one set displaying the above-cited data. The second set includes only flight line magnetic field, temperature, pressure, altitude data plus magnetic field data as measured at a base station. A general description of the area, including descriptions of the various geologic units and the corresponding airborne data, is included.

2562 (GJBX—155(79)(Vol.1)) **Airborne gamma-ray spectrometer and magnetometer survey: DuBois Quadrangle, (Idaho, Montana). Final report.** (Western Geophysical Co. of America, Houston, TX). Jul 1979. Contract EY-76-C-13-1664. 126p. Dep. NTIS PC E06/MF E06.

The 2° x 1° NTMS quadrangle of DuBois was surveyed by air on August 29 to September 21, 1978. Complete data listings of both the reduced single record and the reduced averaged record data are included in this report. A total of 88 uranium anomalies and 11 thorium anomalies have been outlined. (DLC)

2563 (GJBX—155(79)(Vol.2)) **Airborne gamma-ray spectrometer and magnetometer survey: DuBois Quadrangle (Idaho, Montana). Final report.** (Western Geophysical Co. of America, Houston, TX). Jul 1979. Contract EY-76-C-13-1664. 268p. Dep. NTIS, PC A12/MF A01.

Results are presented as anomaly maps, histograms, magnetic and ancillary stacked profile data, and radiometric multiple-parameter stacked profiles. A flight path map is included.

2564 (GJBX—156(79)(Vol.2)) **Aerial radiometric and magnetic survey: Challis National Topographic Map, Idaho.** (Geodata International, Inc., Dallas, TX (USA)). 1979. Contract EY-76-C-13-1664. 264p. Dep. NTIS, PC A12/MF A01.

Stastical analysis results and flight line profile data are presented.

2565 (GJBX—158(79)(Vol.1)) **Aerial gamma ray and magnetic survey: Powder River II Project, the Torrington Quadrangle of Wyoming/Nebraska and Casper Quadrangle, Wyoming. Final report.** (GeoMetrics, Inc., Sunnyvale, CA (USA)). Aug 1979. Contract EY-76-C-13-1664. 86p. Dep. NTIS, PC E06/MF E06.

From September 15 to 28, 1978, geoMetrics, Inc., collected 4320 line miles of high sensitivity airborne radiometric and magnetic data in Wyoming and Nebraska within two 1° x 2° NTMS quadrangles (Torrington and Casper). All radiometric and magnetic data were fully reduced and interpreted by geoMetrics, and are presented as 3 volumes (one Volume I and two Volume II's) in this report. These two quadrangles lie primarily within the Wyoming Basins Physiographic Province. The basin-uplift structure is the dominant geologic trend of the survey area. Major faulting occurs on the boundaries of the uplifts. The majority of exposed rocks are nonmarine sediments of Cenozoic and Mesozoic age. Major uranium ore deposits occur in Tertiary rocks within the Gas Hills, Crooks Gap, and Shirley Basin Districts. Scattered minor occurrences of uranium are found in Phanerozoic and Precambrian rocks throughout the area.

2566 (GJBX—159(79)) **Aerial radiometric and magnetic survey: Elko National Topographic Map, Nevada, Utah.** (Geodata International, Inc., Dallas, TX (USA)). 1979. Contract EY-76-C-13-1664. 270p. Dep. NTIS, PC A12/MF A01.

The results of analyses of the airborne gamma radiation and total magnetic field survey flown for the region identified as the Elko national Topographic Map NK11-12 are presented. The airborne data gathered are reduced by ground computer facilities to yield profile plots of the basic uranium, thorium and potassium equivalent gamma radiation intensities, ratios of these intensities, aircraft altitude above the earth's surface, total gamma ray and earth's magnetic field intensity, correlated as a function of geologic units. The distribution of data within each geologic unit, for all surveyed map lines and tie lines, has been calculated and is included. Two sets of profiled data for each line are included, with one set displaying the above-cited data. The second set includes only flight line magnetic field, temperature, pressure, altitude data plus magnetic field data as measured at a base station. A general description of the area, including descriptions of the various geologic units and the corresponding airborne data, is included.

2567 (K/UR—21(Pt.3)) **National Uranium Resource Evaluation Program. Hydrogeochemical and Stream Sediment Reconnaissance Program in central United States. Semiannual progress report, April 1, 1979-September 30, 1979.** Arendt, J.W. (Oak Ridge Gaseous Diffusion Plant, TN (USA)). 5 Oct 1979. Contract W-7405-ENG-26. 24p. Dep. NTIS, PC A02/MF A01.

Union Carbide Corporation, Nuclear Division (UCC-ND), under contract with the US Department of Energy (DOE), is continuing to conduct its survey of 154 National Topographic Map Series (NTMS) 1° x 2° quadrangles which cover approximately 2,500,000 km² (1,000,000 mi²) of the central United States. A progress report on quadrangle sampling, analyses, and reporting by the Uranium Resource Evaluation (URE) Project is presented. The results of these analyses are also discussed.

2568 (LA—7669-MS) **Uranium hydrogeochemical and stream sediment reconnaissance data release for the Billings NTMS Quadrangle, Montana, including concentrations of forty-three additional elements.** Broxton, D.E. (Los Alamos Scientific Lab., NM (USA)). Aug

1979. Contract EY-76-C-13-1664. 295p. (GJBX—150-(79)). Dep. NTIS, PC A13/MF A01.

This report contains data collected during a geochemical survey for uranium in the Billings quadrangle of south-central Montana. Totals of 1665 water and 1424 sediment samples were collected from 1998 locations in the quadrangle. Histograms and statistical data for uranium concentrations in water and sediment samples and thorium concentrations in sediment samples are given. Elemental concentration, field measurement, weather, geologic, and geographic data for each sample location are listed for waters in Appendix I-A and for sediments in Appendix I-B. Uranium/thorium ratios for sediment samples are also included in Appendix I-B. Appendix II describes standard LASL HSSR field and analytical procedures and explains the codes used in Appendix I. In addition to uranium, waters were analyzed for calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, molybdenum, nickel, titanium, and zinc (Appendix I-A). Sediments were analyzed for uranium and thorium as well as aluminum, antimony, barium, beryllium, bismuth, cadmium, calcium, cerium, cesium, chlorine, chromium, cobalt, copper, dysprosium, europium, gold, hafnium, iron, lanthanum, lead, lithium, lutetium, magnesium, manganese, nickel, niobium, potassium, rubidium, samarium, scandium, silver, sodium, strontium, tantalum, terbium, tin, titanium, tungsten, vanadium, ytterbium, and zinc (Appendix I-B). All elemental analyzes were performed at the LASL. Water samples delayed neutron counting, and plasma-source emission spectroscopy. Sediments were analyzed by delayed neutron counting, neutron activation analysis, x-ray fluorescence, and arc-source emission spectrography.

2569 (LA—7721-PR) **Hydrogeochemical and stream sediment reconnaissance of the National Uranium Resource Evaluation Program primarily for the Rocky Mountain states of New Mexico, Colorado, Wyoming, and Montana, and the State of Alaska. Semiannual progress report, October 1978-March 1979.** Aamodt, P.L.; Bunker, M.E.; Waterbury, G.R.; Waller, R.A. (Los Alamos Scientific Lab., NM (USA)). Jul 1979. Contract EY-76-C-13-1664. 21p. (GJBX—149(79)). Dep. NTIS, PC A02/MF A01.

During this six-month period, Hydrogeochemical and Stream Sediment Reconnaissance samples were collected by the Los Alamos Scientific Laboratory (LASL) from 623 locations in Colorado for a special study. Additional special studies are planned for nine other areas in the Rocky Mountain states in fiscal year 1979, plus some cleanup reconnaissance sampling in parts of four quadrangles that overlap state borders. Preparations for reconnaissance sampling of the entire North Slope region of Alaska have been made but sampling is contingent upon receiving supplemental funds. Water samples from 6725 locations were analyzed for uranium by fluorometry or delayed-neutron counting (DNC). Water samples from 9390 locations were analyzed by emission spectroscopy for 12 other elements. Sediment samples from 14,414 locations were analyzed for uranium and 31 other elements by combined DNC and neutron activation analysis. Sediment samples from 9876 locations were analyzed for two additional elements by x-ray fluorescence. Nine LASL reconnaissance reports, one pilot study data release, one supplemental multielement data release, a multielement data release for three areas in western Alaska, and one quarterly report were open filed by the Department of Energy, Grand Junction Office during the six-month period. Numerous other reports are in various stages of completion and several will be open filed in the near future.

2570 Locating underground uranium deposits. Felice, P.E. (to Westinghouse Electric Corp.). US Patent 4,156,138. 22 May 1979. Filed date 12 Aug 1977. 6p.

Underground uranium deposits are located by placing wires of dosimeters each about 5 to 18 mg/cm² thick underground in a grid pattern. Each dosimeter contains a phosphor which is capable of storing the energy of alpha particles. In each pair one dosimeter is shielded from alpha particles with more than 18 mg/cm² thick opaque material but not gamma and beta rays and the other dosimeter is shielded with less than 1 mg/cm² thick opaque material to exclude dust. After a period underground the dosimeters are heated which releases the stored energy as light. The amount of light produced from the heavily shielded dosimeter is subtracted from the amount of light produced from the thinly shielded dosimeter to give an indication of the location and quantity of uranium underground.

2571 Stratigraphy and uranium potential of early proterozoic metasedimentary rocks in the Medicine Bow Mountains, Wyoming. Karlstrom, K.E.; Houston, R.S. Laramie, WY; Geological Survey of Wyoming (1979). 50p. (NP—24084). Geological Survey of Wyoming, P.O. Box 3008, Laramie, Wyoming 82071.

The Medicine Bow Mountains of southeastern Wyoming contain an eight mile (13 km) thick section of Early Proterozoic (2500 to 1700 My b.p.) metasedimentary rocks which is subdivided into three successions: the Phantom Lake Metamorphic Suite (oldest), Deep Lake Group, and Libby Creek Group. The most promising units are the basal conglomerate of the upper Phantom Lake Suite, which appears to unconformably overlie metavolcanics of the lower Phantom Lake Suite, and the Magnolia Formation, which unconformably overlies the upper Phantom Lake Suite. Outcrops of the former have yielded assays of up to 141 ppM U and 916 ppM Th, with no appreciable gold. Outcrops of the Magnolia Formation have yielded up to 8.4 ppM U and 38 ppM Th. Several factors indicate that these units deserve further study. First, the lithologies of the radioactive and nonradioactive units are remarkably similar to those found in known uranium fossil-placers. Second, the paleogeography was favorable for placer accumulation if the conglomerates are fluvial sediments in an epicontinental clastic succession which was deposited during several transgressive-regressive cycles, as interpreted to be, Third, the age of the conglomerates may be similar to the age of other known uranium placers-i.e., more than 2000 My b.p. And fourth, geological and geochemical studies indicate that both uranium and pyrite have been strongly leached from outcrops and that subsurface rocks contain more uranium than surface rocks do.

ENRICHMENT

2572 Method and apparatus for suppressing electron generation in a vapor source for isotope separation. Janes, G.S. (to Jersey Nuclear-Avco Isotopes, Inc.). US Patent 4,159,421. 26 Jun 1979. Filed date 4 Feb 1977. 12p.

A system for applying accelerating forces to ionized particles of a vapor in a manner to suppress the flow of electron current from the vapor source. The accelerating forces are applied as an electric field in a configuration orthogonal to a magnetic field. The electric field is applied between one or more anodes in the plasma and one or more cathodes operated as electron emitting surfaces. The circuit for applying the electric field floats the cathodes with respect to the vapor source, thereby removing the vapor source from the circuit of electron flow through the plasma and suppressing the flow of electrons from the vapor source. The potential of other conducting structures contacting the plasma is controlled at or permitted to seek a level which further suppresses the flow of electron currents from the vapor source. Reducing the flow of electrons from the vapor source is particularly useful where the vapor is ionized with isotopic selectivity because it avoids superenergization of the vapor by the electron current.

LASER EXCITATION

2573 (LBL—8580, pp 457-483) **Advanced isotope separation technology.** 1978.

In Materials and Molecular Research Division annual report, 1978.

Research in two fields are reported: selective photochemistry, and laser isotope separation. The following compounds were studied: C_2H_5Cl, ICl, H_2CO, HF, CH_3F, SF_6, and C_2F_3Cl. (DLC)

FUELS PRODUCTION AND PROPERTIES

REFER ALSO TO CITATION(S) 2692, 3413

2574 (HEDL-SA—1738-FP) **Dynamic analysis methods for nuclear facilities.** Horsager, B.K. (Hanford Engineering Development Lab., Richland, WA (USA)). 20 Apr 1979. Contract EY-76-C-14-2170. 12p. (CONF-790804—2). Dep. NTIS, PC A02/MF A01.

From 7. conference on electronic computation; St Louis, MO, USA (6 Aug 1979).

A comparison is made between three different dynamic analysis methods commonly used in the analysis of nuclear facilities. The methods are applied to a typical non-reactor type nuclear facility; namely, an early configuration of the High Performance Fuel Laboratory which was to have been designed and constructed to house an automated fuel process line on the Hanford Reservation near Richland, Washington. The fuel to be handled was mixed plutonium and uranium in powder and pellet form which, therefore, required design for severe earthquake and tornado conditions. The structure is a two-story reinforced concrete shear wall building with a high bay on one end. The comparison is made for earthquake motion in the lateral horizontal direction only. The first method employs a three degree of freedom spring mass system with the masses lumped at the three floor and roof slab levels. After shears are obtained they are distributed to the shear walls in proportion to their stiffnesses. Floor and roof slabs are assumed rigid but eccentricities are accounted for in the shear distribution. The second method utilizes a pseudo three-dimensional stick model. The shear walls and horizontal floor and roof diaphram are modeled as three dimensional beam elements using the SAP IV computer Code. All nodal points are in the X, Y plane (Z-0) but motions in this plane are restricted with unrestricted translation in the Z direction. This enables shears to be obtained in all the walls and diaphrams without resorting to lumping walls together and in addition, automatically accounts for eccentricities in

the direction being considered. The third and last model is a three dimensional finite element model. All walls and diaphrams are modeled using plane stress quadrilateral membrane elements again using the SAP IV Computer Code.

2575 (ORNL—5469) **Gel-sphere-pac fuel for thermal reactors: assessment of fabrication technology and irradiation performance.** Beatty, R.L. Norman, R.E.; Notz, K.J. (comps.). (Oak Ridge National Lab., TN (USA)). Nov 1979. Contract W-7405-ENG-26. 194p. Dep. NTIS, PC A09/MF A01.

Recent interest in proliferation-resistant fuel cycles for light-water reactors has focused attention on spiked plutonium and ^{233}U-Th fuels, requiring remote refabrication. The gel-sphere-pac process for fabricating metal-clad fuel elements has drawn special attention because it involves fewer steps. Gel-sphere-pac fabrication technology involves two major areas: the preparation of fuel spheres of high density and loading these spheres into rods in an efficiently packed geometry. Gel sphere preparation involves three major steps: preparation of a sol or of a special solution (broth), gelation of droplets of sol or broth to give semirigid spheres of controlled size, and drying and sintering these spheres to a high density. Gelation may be accomplished by water extraction (suitable only for sols) or ammonia gelation (suitable for both sols and broths but used almost exclusively with broths). Ammonia gelation can be accomplished either externally, via ammonia gas and ammonium hydroxide, or internally via an added ammonia generator such as hexamethylenetetramine. Sphere-pac fuel rod fabrication involves controlled blending and metering of three sizes of spheres into the rod and packing by low- to medium-energy vibration to achieve about 88% smear density; these sizes have diametral ratios of about 40:10:1 and are blended in size fraction amounts of about 60% coarse, 18% medium, and 22% fine. Irradiation test results indicate that sphere-pac fuel performs at least as well as pellet fuel, and may in fact offer an advantage in significantly reducing mechanical and chemical interaction between the fuel and cladding. The normal feed for gel sphere preparation, heavy metal nitrate solution, is the usual product of fuel reprocessing, so that fabrication of gel spheres performs all the functions performed by both conversion and pellet fabrication in the case of pellet technology.

2576 (ORNL/TM—6264) **Partial thermal denitration of uranyl nitrate solutions in a screw denitrator.** Ringel, H.D.; Haas, P.A. (Oak Ridge National Lab., TN (USA)). Aug 1978. Contract W-7405-ENG-26. 38p. Dep. NTIS, PC A03/MF A01.

Weak-acid ion exchange resin is loaded with uranium by acid-deficient uranyl nitrate solutions that have a nitrate uranium ratio of about 1.6. Processing this solution from an acid-excess uranyl nitrate solution by thermal denitration in a screw denitrator is described. Direct processing of this solution resulted in an insufficient acid deficiency of about C/sub N//C/sub U/ = 1.8. Therefore, the process was modified; a highly denitrated UO_3 slid was processed with C/sub N//C/sub U/ = 0.2, and this solid was subsequently dissolved to prepare acid-deficient uranyl nitrate solution or slurry. A detailed flowsheet for this process is given. The proposed combined screw denitrator-dissolver unit may meet the process requiements with improved efficiency.

2577 (ORNL/TM—6960) **Design and evaluation of an on-line fuel rod assay device for an HTGR fuel refabrication plant.** Rushton, J.E.; Allen, E.J.; Chiles, M.M.; Jenkins, J.D. (Oak Ridge National Lab., TN (USA)). Nov 1979. Contract W-7405-ENG-26. 64p. Dep. NTIS, PC A04/MF A01.

Refabricated HTGR fuel rods will contain from ~ 0.15 to 0.5 g ^{233}U and/or ^{235}U. The fuel rods are ~ 16 mm in diameter and 62 mm long. A typical commercial fuel refabrication facility will have six fuel rod production lines, each producing approximately one fuel rod every 4 seconds at design capacity. One on-line assay device will be present for each two production lines. The relative standard deviation in an individual fuel rod fissile material measurement must be less than 3% to satisfy process and quality control requirements. Systematic errors must be kept less than ~ 0.3% for fissile material measured in fuel rods produced over two months to satisfy material accountability requirements. Several nondestructive assay (NDA) methods were investigated. Because the gamma-ray activity of the refabricated fuel is relatively high due to the presence of ^{232}U in the fuel and because the gamma-ray activity is not directly related to total or fissile uranium content, NDA methods employing gamma-ray detection did not appear practicable. A method using thermal neutron irradiation and fast-fission neutron detection was selected. An experimental assay device was fabricated based on this NDA method. Experiments were performed to determine the precision and accuracy of the measurements and to investigate potential interferences and systematic errors. Operating procedures were evaluated, and analysis procedures were identified.

SPENT FUELS REPROCESSING

REFER ALSO TO CITATION(S) 2585, 2602, 2688, 2692

2578 (AGNS—35900-1.2-28) **Studies and research concerning BNFP: shearing tests conducted at Allied-General Nuclear Services for the Consolidated Fuel Reprocessing Program.** Weil, B.; Townes, G. (Allied-General Nuclear Services, Barnwell, SC (USA)). Sep 1979. Contract ET-78-C-09-1040. 42p. (ORNL/TM—7046). Dep. NTIS, PC A03/MF A01.

An experiment conducted to shear two dummy PWR subassemblies is described. Results pertain to the removal of end hardware by shearing, spacer grid fragmentation, the character of sheared product, product leachability, shearing force requirements, and the effects of compaction.

2579 (GA-A—15662) **Availability analysis of an HTGR fuel recycle facility. Summary report.** Sharmahd, J.N. (General Atomic Co., San Diego, CA (USA)). Nov 1979. Contract AT03-76SF71053. 25p. (CONF-791126—1). Dep. NTIS, PC A02/MF A01.

From 26. annual western regional conference of ASQC; San Diego, CA, USA (1 Nov 1979).

An availability analysis of reprocessing systems in a high-temperature gas-cooled reactor (HTGR) fuel recycle facility was completed. This report summarizes work done to date to define and determine reprocessing system availability for a previously planned HTGR recycle reference facility (HRRF). Schedules and procedures for further work during reprocessing development and for HRRF design and construction are proposed in this report. Probable failure rates, transfer times, and repair times are estimated for major system components. Unscheduled down times are summarized.

2580 (RHO-LD—79-3A) **Process technology and process development. Rockwell Hanford Operations semiannual report, October 1978-March 1979.** (Rockwell International Corp., Richland, WA (USA). Rockwell Hanford Operations). Aug 1979. Contract EY-77-C-06-1030. 144p. Dep. NTIS, PC A07/MF A01.

This semiannual report provides information on the technical progress of process technology and process development activities being performed by Research and Engineering, Rockwell Hanford Operations to improve the processing of irradiated reactor fuels, the production of plutonium, and the management of resultant chemical wastes. The work reported herein was performed during the period October 1978 through March 1979.

2581 (SAI—00979-1) **Identification of iodine-129 sources, concentrations, contaminant levels and radioiodine monitoring techniques in LWR reprocessing operations.** Hower, R.B.; Pence, D.T. (Science Applications, Inc., San Diego, CA (USA)). Oct 1978. Contract EY-77-C-09-0979. 41p. Dep. NTIS, PC A03/MF A01.

Six proposed reprocessing facility designs are described. The potential sources and concentrations of I-129 in each facility are determined and the effects of voloxidation are discussed. The sources and concentrations of NO, NO_2, water vapor, and organic contaminants are also disccussed. Iodine-129 monitoring requirements for process and stack gas streams are determined based on averages of expected I-129 concentrations at the six proposed facilities. Various monitoring techniques are summarized, including LEPS (Low Energy Photon Spectrometry), mass spectrometry, and laser-based methods. The mass spectrometric methods which are potentially sensitive enough are medium pressure photoionization, molecular beam photoionization, surface ionization, and API (Atmospheric Pressure Ionization). The laser-based methods which have the appropriate sensitivities are the laser-induced fluorescence monitor and the intracavity dye laser.

2582 **Investigation of the reprocessing and waste management requirements of present and alternative nuclear fuel cycles.** Rochlin, G.I. Sacramento, CA; California Energy Commission (1979). 158p. (NP—24158(Vol.1)). California Energy Commission, 1111 Howe Ave., Sacramento, CA, 95825.

This study examines various nuclear fuel cycles with regard to economics, health and safety, and proliferation implications. Emphasis is placed on the question of whether reprocessing of nuclear fuel is required in particular fuel cycles. This emphasis is prompted by California state law, which prohibits (under certain conditions) the licensing of nuclear fission thermal power plants requiring the reprocessing of fuel rods. The report concludes that there are several fuel cycles, including the light water reactor cycle, which do not require reprocessing on technical or resource/economic grounds. The final decision to reprocess in many cases depends upon the resolution of environmental, health, and safety issues.

2583 **Investigation of the reprocessing and waste management requirements of present and alternative nuclear fuel cycles. Volume II. Appendices.** Rochlin, G.I. Sacramento, CA; California Energy Commission (1979). 197p. (NP—24158(Vol.2)). California Energy Commission, 1111 Howe Ave., Sacramento, CA, 95825.

The following appendices are included: spread of nuclear power, data from Nuclear Proliferation Factbook, LWR fuel cycle descriptions and flowsheets, thorium fuel cycles in LWRs, LWR-thorium and advanced LWR cycles, thorium fuel cycle in HWRs, CANDU and advanced HWR cycles, thorium fuel cycles in HTGRs, HTGR cycles, fast breeder fuel cycles, and technical safeguard features of advanced fuel cycles. (DLC)

TRANSPORT AND STORAGE

REFER ALSO TO CITATION(S) 2604, 2655, 2674, 2679, 2685, 2687

2584 (AGNS—35900-1.3-2) **Studies and research concerning BNFP: life of project operating expenses for away-from-reactor (AFR) spent fuel storage facility. Final report.** Shallo, F.A. (Allied-General Nuclear Services, Barnwell, SC (USA)). Sep 1979. Contract ET-78-C-09-1040. 36p. Dep. NTIS, PC A03/MF A01.

Life of Project operating expenses for a licensed Away-From-Reactor (AFR) Spent Fuel Storage Facility are developed in this report. A comprehensive business management structure is established and the functions and responsibilities for the facility organization are described. Contractual provisions for spent fuel storage services are evaluated.

2585 (AGNS—35900-1.3-32) **Studies and research concerning BNFP: converting reprocessing plant's fuel receiving and storage area to an away-from-reactor (AFR) storage facility. Final report.** Cottrell, J.E.; Shallo, F.A.; Musselwhite, E.L.; Wiedemann, G.F.; Young, M. (Allied-General Nuclear Services, Barnwell, SC (USA)). Sep 1979. Contract ET-78-C-09-1040. 78p. Dep. NTIS, PC A05/MF A01.

Converting a reprocessing plant's fuel receiving and storage station into an Away-From-Reactor storage facility is evaluated in this report. An engineering analysis is developed which includes (1) equipment modifications to the facility including the physical protection system, (2) planning schedules for licensing-related activities, and (3) cost estimates for implementing such a facility conversion. Storage capacities are evaluated using the presently available pools of the existing Barnwell Nuclear Fuel Plant-Fuel Receiving and Storage Station (BNFP-FRSS) as a model.

2586 (AGNS—35900-CONF-41) **Spent fuel disassembly and canning programs at the Barnwell Nuclear Fuel Plant (BNFP).** Townes, G.A. (Allied-General Nuclear Services, Barnwell, SC (USA)). Oct 1979. Contract ET-78-C-09-1040. 16p. (CONF-791103—40). Dep. NTIS, PC A02/MF A01.

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

Methods of disassembling and canning spent fuel to allow more efficient storage are being investigated at the BNFP. Studies and development programs are aimed at dry disassembly of fuel to allow storage and shipment of fuel pins rather than full fuel assemblies. Results indicate that doubling existing storage capacity or tripling the carrying capacity of existing transportation equipment is achievable. Disassembly could be performed in the BNFP hot cells at rates of about 12 to 15 assemblies per day.

2587 (BAW—1484-1) **Critical experiments supporting close proximity water storage of power reactor fuel. Technical progress report, October 1-December 31, 1978.** Baldwin, M.N.; Hoovler, G.S. (Babcock and Wilcox Co., Lynchburg, VA (USA)). Mar 1978. Contract EY-77-C-09-1001. 20p. Dep. NTIS, PC A02/MF A01.

Experimental measurements are being conducted on critical configurations of clusters of fuel rods mocking up LWR-type fuel elements in close proximity water storage. The square clusters with 14 rods on each side are arranged in 3 x 3 arrays. Both the spacing between the fuel clusters and the intervening material are being varied to provide a variety of benchmark loadings. The KENO IV code and the PDQ07 code (in selected cases) will be used to analyze each benchmark loading to determine the calculated k/sub eff/ of each configuration. Experimental results obtained during the fourth calendar quarter of 1977 are presented.

2588 (BAW—1484-3) **Critical experiments supporting close proximity water storage of power reactor fuel.** Baldwin, M.N.; Hoovler, G.S.; Eng, R.L.; Welfare, F.G. (Babcock and Wilcox Co., Lynchburg, VA (USA)). Sep 1978. Contract EY-77-C-09-1001. 14p. Dep. NTIS, PC A02/MF A01.

Experimental measurements are being taken on critical configurations of clusters of fuel rods mocking up LWR-type fuel elements in close proximity water storage. The results will serve to benchmark the computer codes used in designing nuclear power reactor fuel storage racks.

2589 (BAW—1484-5) **Critical experiments supporting close proximity water storage of power reactor fuel. Technical progress report, October 1-December 31, 1978.** Baldwin, M.N.; Hoovler, G.S.; Eng, R.L.; Welfare, F.G. (Babcock and Wilcox Co., Lynchburg, VA (USA)). Mar 1979. Contract EY-77-C-09-1001. 40p. Dep. NTIS, PC A03/MF A01.

Experimental measurements are being taken on critical configurations of clusters of fuel rods mocking up LWR-type fuel elements in close proximity water storage. The results will serve to benchmark the computer codes used in designing nuclear power reactor fuel storage racks.

2590 (NEDG—21889) **Spent fuel receipt and storage at the Morris Operation.** Astrom, K.A.; Eger, K.J. (General Electric Co., San Jose, CA (USA). Nuclear Energy Div.). Jun 1978. Contract EY-76-C-04-0789. 95p. Dep. NTIS, PC A05/MF A01.

Operating and maintenance activities in an independent spent fuel storage facility are described, and current regulations governing such activities are summarized. This report is based on activities at General Electric's licensed storage facility located near Morris, Illinois, and includes photographs of cask and fuel handling equipment used during routine operations.

WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 2582, 2583

2591 (CONF-790420—, pp 27-32) **Influence of system considerations on waste form design.** Bauer, A.A.; Matthews, S.C.; Peterson, R.W. (Office of Nuclear Waste Isolation, Columbus, OH). May 1979.

From International symposium on ceramics in nuclear waste management; Cincinnati, OH, USA (30 Apr 1979).

The design of waste forms is constrained by waste management system considerations imposed during generation, treatment, packaging, transportation, storage, and isolation. In the isolation phase, the waste form provides one of the barriers to release in a multibarrier system that includes the natural geologic and hydrologic barriers as well as other engineered barriers.

2592 (CONF-790420—, pp 333-337) **Stress analysis of glass-canister interaction: a study of residual stresses and fracturing.** Simonen, F.A.; Friley, J.R. (Battelle Pacific Northwest Labs., Richland, WA). May 1979.

From International symposium on ceramics in nuclear waste management; Cincinnati, OH, USA (30 Apr 1979).

Residual stresses and cracking in canisters filled with vitrified nuclear waste are simulated using finite element computer calculations. Cooling rates, internal heat generation, and thermal expansion coefficients significantly affect stress levels. Glass behavior within the softening temperature range is taken to follow the instant freezing concept of Bartenev.

2593 (CONF-790420—, pp 365-369) **Characteristics of stored high-level ICPP waste calcine.** Staples, B.A.; Pomiak, G.S.; Wade, E.L. (Allied Chemical Corp., Idaho Falls, ID). May 1979.

From International symposium on ceramics in nuclear waste management; Cincinnati, OH, USA (30 Apr 1979).

Calcined high-level radioactive defense waste stored at the Idaho Chemical Processing Plant for up to twelve years was sampled for retrievability. The calcine was determined to be retrievable as expected. A program to determine physical and chemical characterisitcs for future retrieval and alternative waste treatment processes has been completed.

2594 (DP—1488(Add.)) **Electrical resistivities of glass melts containing simulated SRP waste sludges.** (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). 1978. Contract EY-76-C-09-0001. 6p. Dep. NTIS, PC A02/MF A01.

This addendum corrects the resistivities for Frit 21 glass melts for the resistance developed at high temperatures by the Pt wires in the resistivity probe. (DLC)

2595 (LA—7921-PR) **Nuclear waste management technology development activities. Progress report, January-December 1978.** Johnson, L.J.; Desilets, B.H. (comps.). (Los Alamos Scientific Lab., NM (USA)). Jun 1979. Contract W-7405-ENG-36. 73p. Dep. NTIS, PC A04/MF A01.

Summary reports describe progress in Los Alamos Scientific Laboratory (LASL) Health Research Division managed programs by the nuclear waste management task area for calendar year (CY) 1978. Development and application of assay instrumentation for measuring the radioactivity content of waste packages is reported. Work in developing test materials and laser-based instrumentation for in-place testing of high-efficiency particulate aerosol filters is discussed. Development and demonstration of a controlled air incinerator for treatment of radioactively contaminated combustible waste is described. Field data from the environmental geology and hydrology aspect of shallow earth disposal of radioactively contaminated waste are reviewed and related to improvement of land burial technology.

2596 (NVO—185(Rev.1)) **Operational Radioactive Waste Management Plan for the Nevada Test Site.** (Reynolds Electrical and Engineering Co., Inc., Las Vegas, NV (USA); Department of Energy, Las Vegas, NV (USA). Nevada Operations Office). Jul 1979. Contract EY-76-C-08-0410. 44p. Dep. NTIS, PC A03/MF A01.

The Operational Radioactive Waste Management Plan for the Nevada Test Site establishes procedures and methods for the safe receiving, processing, disposal, or storage of radioactive waste. Included are NTS radioactive waste disposition program guidelines, procedures for radioactive waste management, description of storage areas and facilities, and a glossary of specifications and requirements.

2597 (PNL—3000-2) **Nuclear waste management. Quarterly progress report, April-June 1979.** Platt, A.M.; Powell, J.A. (comps.). (Battelle Pacific Northwest Labs., Richland, WA (USA)). Sep 1979. Contract EY-76-C-06-1830. 53p. Dep. NTIS, PC A04/MF A01.

Progress is reported on: decontamination and densification of chop-leach cladding residues; monitoring methods for particulate and gaseous effluents from waste solidification process; TRU waste immobilization; krypton solidification; ^{14}C and ^{129}I fixation; waste management system and safety studies; waste isolation safety assessment; well logging instrumentation development for shallow land burial; monitoring and physical characterization of unsaturated zone transport; detection and characterization of mobile organic complexes of fission products; and electropolishing for surface decontamination of metals. 9 figures, 14 tables. (DLC)

2598 (RHO-SA—50) **Instrument for determining viscosities and electrical resistivities of molten glass candidates for immobilizing Hanford nuclear defense wastes.** Riebling, E.F. (Rockwell International Corp., Richland, WA (USA). Rockwell Hanford Operations). Sep 1978. Contract EY-77-C-06-1030. 40p. Dep. NTIS, PC A03/MF A01.

Viscosity and electrical resistivity information is required for a variety of glass melts as part of laboratory plant glass composition screening programs and/or part of pre-pilot plant parametric studies of glass composition/physical property relationships. This report describes the design specifications and calibration procedures of a recently assembled, dual-purpose, viscosity/electrical resistivity instrument. The instrument can detect molten glass viscosity between 10 and 16,000 poise and electrical resistivities larger than 2Ω.cm at temperatures between 1,000 and 1,550°C.

2599 (SAND—79-0117) **Gas generation from transuranic waste degradation: an interim assessment.** Molecke, M.A. (Sandia Labs., Albuquerque, NM (USA)). Oct 1979. Contract EY-76-C-04-0789. 53p. Dep. NTIS, PC A04/MF A01.

A review of all available, applicable data pertaining to gas generation from the degradation of transuranic waste matrix material and packaging is presented. Waste forms are representative of existing defense-related TRU wastes and include cellulosics, plastics, rubbers, concrete, process sludges, and mild steel. Degradation mechanisms studied were radiolysis, thermal, bacterial, and chemical corrosion. Gas generation rates are presented in terms of moles of gas produced per year per drum, and in G(gas) values for radiolytic degradation. Comparison of generation rates is made, as is a discussion of potential short- and long-term concerns. Techniques for reducing gas generation rates are discussed. 6 figures, 10 tables.

2600 **Science underlying radioactive waste management: status and needs.** Roy, R. (Pennsylvania State Univ., University Park, PA). pp 1-20 of Scientific basis for nuclear waste management. McCarthy, G.J. (ed.). New York, NY; Plenum Press (1979).

From Annual meeting of Materials Research Society; Boston, MA, USA (28 Nov 1978).

The technical system constitutes a major - but not necessarily determinative - component of the national plan (or system) for radioactive waste management (RWM). This technical RWM system can be conveniently divided into four subsystems: Storage; Radionuclide Immobilization; Isolation and Post Emplacement. It is essential to consider the interactions among these four subsystems in designing any system. Of these, the first and last have not been given much consideration and their role is delineated herein. Of the middle subsystems, up to 1978 the system designers have relied essentially exclusively on the Isolation subsystem (i.e., removal from the biosphere in a mine or seabed, preventing migration of ions, etc.). History has shown that technically this strategy has proved unacceptable. In the last two years the role of the solid waste form and thence the entire radionuclide immobilization subsystem has assumed a much more significant role. Indeed, it will be shown that recent research results give grounds for hope that this subsystem may carry most of the burden of proof of acceptable and verifiable removal of radionuclides from the biosphere. Recent research results which made some of this possible will be discussed, and indications provided where new science is needed in all four subsystems.

WASTE PROCESSING

REFER ALSO TO CITATION(S) 2580, 3437

2601 (ANL—78-13) **Decontaminaion of metals containing plutonium and americium.** Seitz, M.G.; Gerding, T.J.; Steindler, M.J. (Argonne National Lab., IL (USA)). Jun 1979. Contract W-31-109-ENG-38. 57p. Dep. NTIS, PC A04/MF A01.

Melt-slagging (melt-refining) techniques were evaluated as a decontamination and consolidation step for metals contaminated with oxides of plutonium and americium. Experiments were performed in which mild steel, stainless steel, and nickel contaminated with oxides of plutonium and americium were melted in the presence of silicate slags of various compositions. The metal products were low in contamination, with the plutonium and americium strongly fractionated to the slags. Partition coefficients (plutonium in slag/plutonium in steel) of 7×10^6 were measured with boro-silicate slag and of 3×10^6 with calcium, magnesium silicate slag. Decontamination of metals containing as much as 14,000 ppM plutonium appears to be as efficient as for metals with plutonium levels of 400 ppM. Staged extraction, that is, a remelting of processed metal with clean slag, results in further decontamination of the metal. The second extraction is effective with either resistance-furnace melting or electric-arc melting. Slag adhering to the metal ingots and in defects within the ingots is in the important contributors to plutonium retained in processed metals. If these sources of plutonium are controlled, the melt-refining process can be used on a large scale to convert highly contaminated metals to homogeneous and compact forms with very low concentrations of plutonium and americium. A conceptual design of a melt-refining process to decontaminate plutonium- and americium-contaminated metals is described. The process includes single-stage refining of contaminated metals to produce a metal product which would have less than 10 nCi/g of TRU-element contamination. Two plant sizes were considered. The smaller conceptual plant processes 77 kg of metal per 8-h period and may be portable.The larger one processes 140 kg of metal per 8-h period, is stationary, and may be near te maximum size that is practical for a metal decontamination process.

2602 (CONF-791112—17) **Technical feasibility of krypton-85 storage in sodalite.** Benedict, R.W.; Christensen, A.B.; Del Debbio, J.A.; Keller, J.H.; Knecht, D.A. (Exxon Nuclear Idaho Co., Inc., Idaho Falls (USA)). 1979. Contract EY-76-C-07-1570. 7p. Dep. NTIS, PC A02/MF A01.

From Symposium on the scientific basis for nuclear waste management; Boston, MA, USA (26 Nov 1979).

Based on these experimental results, the process that is technically feasible for a reference 2000 metric ton of heavy metal (MTHM) per year reprocessing plant producing ~ 17 MCi or ~ 190 m^3 at STP would encapsulate krypton at ~ 20 cm^3/g from krypton at temperatures greater than 575°C and pressures greater than 1600 atm with one batch a day in a 58-L high pressure vessel. Based on preliminary measurements at 500°C, the same process also would be feasible for a 70% krypton and 30% xenon mixture. 7 figures.

2603 (DOE/EV—0046(Vol.2), pp 224-235) **Volume reduction of metallic waste.** Beitel, G.A.; Ortiz, P.G. (Rockwell Hanford Operations, Richland, WA). Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

Most metallic waste from nuclear materials processing operations is bulky and awkward to handle. The waste classed as transuranic will have to be placed in containers of limited size prior to disposal. Maximizing the density of such waste could greatly reduce the cost of disposal in addition to improving the quality of the waste form. The arc saw is being developed to rapidly dismantle large, radioactively contaminated equipment items in preparation for disposal. The arc saw has already been shown to cut materials with a wider variety of shapes and composition, and at higher rates than a plasma torch. A complete saw system has been built to research the full capability of the saw and to assist in the design of a second-generation saw system which will dismantle vessels up to ten feet in diameter and weigh up to ten tons. The performance of the existing saw is discussed, and the design of the next saw is described. Containment of the fumes, equipment maintenance, and safety have been identified as the major obstacles to melting radioactively contaminated steel. A vacuum furnace system which promises to overcome these obstacles has been designed and is being built. The furnace design is described in detail.

2604 (DOE/EV—0046(Vol.2), pp 245-257) **Radioactive waste: availability of solutions.** Meyers, S. (Department of Energy, Washington, DC). Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

Prior reviews of the availability of technology to achieve the goals of radioactive waste management have generally concluded that the basic technologies are available and that the tasks at hand can be categorized as those of reducing technology to practical

application. The most comprehensive of these reviews was published in 1976 as ERDA-76-43. The availability of technologies for the four basic waste management functions of storage, treatment, transportation, and disposal is summarized, noting whether the technology is commercially available; ready for initiation of design and construction of a full-scale commercial installation, with possible design verification testing needed; or under development. For the waste management functions to be executed by DOE itself, the scope, direction, and timing of the technology implementation program is reviewed, including the status of the Fiscal Year 1979 budget. Considerations of the constraints imposed by public understanding, regulatory and environmental statement procedures, and relations with state and local governments are also reviewed. Assuming the final decision on commercial nuclear fuel reprocessing has not been made by the date of the symposium, the effects of this uncertainty on the program will be covered, i.e., the uncertainty introduces a need for two-contigency planning, but the basic technology is considered available for both contingencies.

2605 (DOE/EV—0046(Vol.2), pp 339-355) **Waste treatment research and development.** Walton, R.D. Jr. (Department of Energy, Washington, DC); Dempsey, J.C.; Brown, R.; Goldberg, E.S.; Lowrey, R.Y. Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

In the standard flowsheets for reprocessing of spent nuclear fuel, either for defense or commercial purposes, nearly all the waste radionuclides are isolated from the useful radionuclides in a single waste stream, traditionally known as high-level liquid waste. Although there have been some concepts for geologic disposal of this waste in liquid form, the usual planning assumptions are that it will be solidified and packaged in relatively compact units to facilitate transport and geologic emplacement. In view of the indefinite deferral of commercial spent fuel reprocessing, the current DOE development work on high-level liquid waste treatment is focused on its own sites. By volume, most of this waste is in the form of damp, bulk salt cakes or sludges stored in underground tanks at the Hanford and Savannah River sites. The status of planning for the retrieval, solidification, and packaging of this material, and also on the ongoing solidification work at the Idaho site are reviewed.

2606 (DP—1535) **Small-scale, joule-heated melting of Savannah River Plant waste glass. I. Factors affecting large-scale vitrification tests.** Plodinec, M.J.; Chismar, P.H. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). Oct 1979. Contract EY-76-C-09-0001. 33p. Dep. NTIS, PC A03/MF A01.

A promising method of immobilizing SRP radioactive waste solids is incorporation in borosilicate glass. In the reference vitrification process, called joule-heated melting, a mixture of glass frit and calcined waste is heated by passage of an electric current. Two problems observed in large-scale tests are foaming and formation of an insoluble slag. A small joule-heated melter was designed and built to study problems such as these. This report describes the melter, identifies factors involved in foaming and slag formation, and proposes ways to overcome these problems.

2607 (DP-MS—79-42) **Vitrification of Savannah River Plant radioactive waste: process development studies.** Plodinec, M.J. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). 1979. Contract EY-76-C-09-0001. 20p. (CONF-791061—1). Dep. NTIS, PC A02/MF A01.

From American Ceramic Society fall meeting; Bedford, PA, USA (10 Oct 1979).

The reference process for disposal of radioactive waste from the Savannah River Plant is vitrification into borosilicate glass. The effects of frit composition and frit particle size, batch chemicals, soluble salts, charcoal, argon atmosphere, and viscosity on the melting process are discussed.

2608 (DP-MS—79-70) **Development of solid radionuclide waste forms in the United States.** Crandall, J.L. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). 1979. Contract EY-76-C-09-0001. 15p. (CONF-791112—12). Dep. NTIS, PC A02/MF A01.

From Symposium on the scientific basis for nuclear waste management; Boston, MA, USA (26 Nov 1979).

New ways of reworking the wastes require a new classification in terms of the final waste forms. This paper surveys the candidate forms: encapsulation binders, in-place solidification waste forms, glass and ceramic waste forms, mineral waste forms, matrix waste forms, gaseous waste forms (fixation), and canisters and engineered barriers. Participants in the US-high-level waste form development program are listed. Requirements and selection of waste forms are also discussed. 26 references. (DLC)

2609 (MLM—2644) **Polymer impregnated tritiated concrete. Final report.** Wieneke, R.E.; Dauby, J.J.; Abell, G.C.; Tadlock, W.E.; Lamberger, P.H.; Gibbs, G.E. (Mound Facility, Miamisburg, OH (USA)). 27 Sep 1979. Contract EY-76-C-04-0053. 31p. Dep. NTIS, PC A03/MF A01.

Mound Facility investigated the polymer-impregnated tritiated-concrete process (PITC) for aqueous tritiated waste as developed by Brookhaven National Laboratory. This technique involves the solidification of tritiated aqueous waste in concrete. The solidified block is then soaked in styrene monomer which permeates the concrete and, when polymerized, effectively microencapsulates the tritium bearing concrete, thus providing added protection in case of a broken package. Small scale samples (in 500-ml polyethylene bottles) were fabricated and tested in order to determine their characteristics in relation to differences in tritium release from the package due to variation of process parameters, radiation effects on the polystyrene, and gas generation. It was determined that varying the factors that increase the polymerization rate of the styrene (higher temperature or more catalyst) will increase the tritium permeation rate because the porosity of the polystyrene layer has been increased. Compressive strength tests, conducted after 75 weeks, showed that the tritiated blocks were consistently weaker than their nonradioactive counterparts, and that the gas release rate from PITC samples was nearly the same as that from nonpolymer impregnated samples. To date, two full-scale, nonradioactive packages have been successfully produced by the following procedure: inject 27 liters of water into the center of the waste package that contains 112 kg of Portland Type III cement inside a 30-gal, open-head steel drum and a 27-gal polyethylene drum liner; cure the cement at ambient temperature for 3 to 5 days, then heat the package to 45°C and soak the cement with 24 kg of styrene monomer containing 3/4 wt % catalyst; increase the heat until 70°C is obtaind at the cement-liner interface. In approximately 7 hr, polymerization will occur.

2610 (PNL—2668-3) **Multibarrier waste forms. Part III: Process considerations.** Lokken, R.O. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Oct 1979. Contract EY-76-C-06-1830. 32p. Dep. NTIS, PC A03/MF A01.

The multibarrier concept for the solidification and storage of radioactive waste utilizes up to three barriers to isolate radionuclides from the environment: a solidified waste inner core, an impervious coating, and a metal matrix. The coating and metal matrix give the composite waste form enhanced inertness with improvements in thermal stability, mechanical strength, and leach resistance. Preliminary process flow rates and material costs were evaluated for four multibarrier waste forms with the process complexity increasing thusly: glass marbles, uncoated supercalcine, glass-coated supercalcine, and PyC/Al_2O_3-coated supercalcine. This report discusses the process variables and their effect on optimization of product quality, processing simplicity, and material cost. 11 figures, 2 tables. (DLC)

2611 (RFP—2952) **Chemistry research and development. Progress report, November 1978-April 1979.** Miner, F.J. (Rockwell International Corp., Golden, CO (USA). Rocky Flats Plant). 5 Oct 1979. Contract EY-76-C-04-3533. 35p. Dep. NTIS, PC A03/MF A01.

The status of the following studies is given: calorimetry and thermodynamics of nuclear materials; americium recovery and purification; optimization of the cation exchange process for recovering americium and plutonium from molten net extraction residues; evaluation and comparison of bidentate extractants and methods for actinide recovery; a combined anion exchange-bidontate organophosphorus extraction process for molten salt extraction residues; a combined anion exchange-extraction chromatography technique for secondary recovery; plutonium recovery in the Advanced Size Reduction Facility; decontamination of Rocky Flats soil; separating lead and calcium from americium by chromate and oxalate precipitation; demonstration of the pyroredox process in the induction-heated, tilt-pour furnace; process development for recovery of americium from vacuum melt furnace crucibles; plutonium peroxide precipitation process; and a comparative study of annular and Raschig ring-filled tanks.

2612 **Scientific basis for nuclear waste management.** McCarthy, G.J. (ed.). Contract ET-78-C-02-5009. New York, NY; Plenum Press (1979). 581p. (CONF-781121—(Vol.1)). Plenum Press, 227 West 17th Street, New York, NY.

From Annual meeting of Materials Research Society; Boston, MA, USA (28 Nov 1978).

Seventy-two papers were presented. Sessions were held o: waste solidification, waste isolation, cement and concrete in solidification and isolation, and modeling and safety assessment. Individual papers were processed for the data base.

2613 **Techniques for high level waste solidification in Europe.** Heimerl, W. (Deutsche Gesellschaft fuer Wiederaufarbeitung von Kernbrennstoffen GmbH, Hanover, Germany). pp 21-29 of Scientific basis for nuclear waste management. McCarthy, G.J. (ed.). New York, NY; Plenum Press (1979).

From Annual meeting of Materials Research Society; Boston, MA, USA (28 Nov 1978).

A review of progress toward the development and demonstration of a solidification process for high level waste solutions on an industrial scale in four European countries (France, United Kingdom, Germany and Belgium) is given. Historical development, present status and future plans are presented. Three of the processes which seem to be of major importance are descirbed (AVM-France, HARVEST-United Kingdom, PAMELA-Germany).

2614 Preparation and characterization of an improved high level radioactive waste (HAW) borosilicate glass. Guber, W.; Hussain, M.; Kahl, L.; Ondracek, G.; Saidl, J. (Kernforschungszentrum, Karlsruhe, Germany). pp 37-42 of Scientific basis for nuclear waste management. McCarthy, G.J. (ed.). New York, NY; Plenum Press (1979).

From Annual meeting of Materials Research Society; Boston, MA, USA (28 Nov 1978).

Five series of modified glasses based on a reference borosilicate formulation (GP 98) have been prepared and investigated. On the basis of comparisons of properties of the different glasses, two compositions have been selected for more detailed investigations and for technical application in the future. Simultaneously, glass products with real HAW oxides from German fuel reprocessing have been investigated. No structural change caused by irradiation has been detected after two year shortage.

2615 Vitrification of high sodium-aluminum wastes: composition ranges and properties. Brezneva, N.E.; Minaev, A.A.; Oziraner, S.N. (Institute of Physical Chemistry, Moscow, USSR). pp 43-50 of Scientific basis for nuclear waste management. McCarthy, G.J. (ed.). New York, NY; Plenum Press (1979).

From Annual meeting of Materials Research Society; Boston, MA, USA (28 Nov 1978).

Studies of the vitrification of wastes that contain sodium and aluminum are summarized. High Na-Al-wastes can be vitrified to form both phosphate and borosilicate glasses having suitably low leaching rates. Up to 50 wt % waste oxides can be vitrified. From the technological viewpoint, phosphate glasses have two advantages over borosilicate types: they have low melting ranges and the glass-forming additives can be liquid. Cs volatility depends on a diffusion mechanism and is about 5% at 1000°C. All Ru volatilizes during melting but Ru volatility can be reduced to 5 to 10% by addition of reducing agents to the melt.

2616 Non-radioactive operation experience with a joule heated ceramic melter for vitrification of high-level liquid waste. Weisenburger, S. (Kernforschungszentrum, Karlsruhe, Germany). pp 51-56 of Scientific basis for nuclear waste management. McCarthy, G.J. (ed.). New York, NY; Plenum Press (1979).

From Annual meeting of Materials Research Society; Boston, MA, USA (28 Nov 1978).

A ceramic-lined melter for HLLW-vitrification has been tested at Karlsruhe Nuclear Research Center. The results of these tests look very promising and are described in detail. Further development of the vitrification unit are outlined in respect to remote operation and process control.

2617 Natural glasses: analogues for radioactive waste forms. Ewing, R.C. (Univ. of New Mexico, Albuquerque). pp 57-68 of Scientific basis for nuclear waste management. McCarthy, G.J. (ed.). New York, NY; Plenum Press (1979).

From Annual meeting of Materials Research Society; Boston, MA, USA (28 Nov 1978).

The long-term effects of alteration and radiation damage on waste glass forms are difficult to assess in time-limited laboratory experiments. It is important to evaluate the long-term stability of naturally occurring analogues. Age distributions and alteration effects observed in natural glasses in different geologic environments provide insight into variables controlling the rates of devitrification, alteration and radiation damage. Volcanic glasses are often altered by weathering and leaching, crystallizing to their fine-grained compositional equivalents (rhyolites and felsites). The oldest reliably dated volcanic glasses are 40 million years old, but the majority of the dated glasses are much younger. Experimental studies have produced devitrification textures; and laboratory experiments, as well as empirical measurements, have determined hydration rates for volcanic glasses as a function of composition, temperature and climate. The presence of water and the temperature are the most important rate controlling variables. Even material that still may be described as glassy often exhibits evidence of alteration and crystallization. Of the volcanic glasses that are preserved in the geologic record it would be rare to describe such a glass as pristine. Glasses formed as a result of impact, tektites and lunar glasses, may occur in a substantially unaltered form. In the case of tektites, their resistance to alteration is a result of their high SiO_2 and low alkali content. Lunar glasses have been preserved for hundreds of millions of years because they exist in a dry environment. Direct comparisons between the stabilities of natural glasses and waste glasses are inappropriate because their compositions and thermal histories are very different; however, natural glasses may serve as standards of comparison, and they suggest experimental techniques that allow the evaluation of the long term stability of glass waste forms.

2618 Characterization of glass and glass ceramic nuclear waste forms. Lutze, W.; Borchardt, J.; De. A.K. (Hahn-Meitner-Institut fuer Kernforschung, GmbH, Germany). pp 69-81 of Scientific basis for nuclear waste management. McCarthy, G.J. (ed.). New York, NY; Plenum Press (1979).

From Annual meeting of Materials Research Society; Boston, MA, USA (28 Nov 1978).

Characteristics of solidified nuclear waste forms, glass and glass ceramic compositions and the properties (composition, thermal stability, crystallization, phase behavior, chemical stability, mechanical stability, and radiation effects) of glasses and glass ceramics are discussed. The preparation of glass ceramics may be an optional step for proposed vitrification plants if tailored glasses are used. Glass ceramics exhibit some improved properties with respect to glasses. The overall leach resistance is similar to that of glasses. An increased leach resistance may become effective for single radionuclides being hosted in highly insoluble crystal phases mainly when higher melting temperatures are applicable in order to get more leach resistant residual glass phases. The development of glass ceramic is going on. The technological feasibility is still to be demonstrated. The potential gain of stability when using glass ceramics qualifies the material as an alternative nuclear waste form.

2619 Thermal, chemical and radiation stability of vitreous radioactive wastes. Nikiforov, A.S.; Kulichenko, V.V.; Krylova, N.V.; Mustatov, N.D.; Polyakov, A.S. (All-Union Scientific Research Inst. of Inorganic Materials, Moscow, USSR). pp 117-121 of Scientific basis for nuclear waste management. McCarthy, G.J. (ed.). New York, NY; Plenum Press (1979).

From Annual meeting of Materials Research Society; Boston, MA, USA (28 Nov 1978).

Some USSR studies of the chemical, thermal, and radiation stabiity of silicate glasses and glass-like products are reviewed briefly. Compositional effects on chemical stability of nuclear waste glasses correspond to well known commercial glass behavior, namely that chemical stability increases with increasing SiO_2 and Al_2O_3 content and decreases with increased alkali metal oxides. The rate of ^{137}Cs leaching varied according to the chemical composition, with the high SiO_2 materials showing the lowest rates at 10^{-6} g $cm^{-2}d^{-1}$. The leachability of ^{90}Sr followed similar trends. Release of radioisotopes from glass-like products can also occur without contact with water, namely by evaporation or disintegration of the materials. Contamination through a gas phase is also observed in the process of storage of glass-like samples at room temperature. Radiation induced sublimates are not only observed after the storage of radioactive materials, but also after the irradiation of inactive ones using a ^{60}Co source. Effects of storage of glass-like products at elevated temperatures on their subsequent chemical stability in water are described. A variety of materials was studied, and they showed increases, decreases, and no change in stability. Three classes of materials were studied in order to explore the effects of structural changes resulting from heat treatment on chemical stability in water.

2620 Development of multibarrier nuclear waste forms. Rusin, J.M. (Battelle Pacific Northwest Labs., Richland, WA); Browning, M.F.; McCarthy, G.J. pp 169-180 of Scientific basis for nuclear waste management. McCarthy, G.J. (ed.). New York, NY; Plenum Press (1979).

From Annual meeting of Materials Research Society; Boston, MA, USA (28 Nov 1978).

The multibarrier concept aims to separate the radionuclide-containing inner core material and the environment by the use of coatings and metal matrices. The resultant composite waste form exhibits enhanced inertness due to improved thermal stability and mechanical strength, and the added barriers greatly improve leach resistance. Two options were developed for the inner core of the multibarrier concept: supercalcine pellets and glass marbles. The development of coatings for supercalcine was pursued to provide an additional protective layer between the radionuclides and the environment. The coatings include the application of a 40 μm pyrolytic carbon layer as a barrier to enhance leach resistance and a 60-μm Al^2O^3 layer as a barrier to increase oxidation resistance. Glass coating of supercalcine by frit and glaze was also investigated.

2621 Metal encapsulation of ceramic nuclear waste. Jardine, L.J.; Steindler, M.J. (Argonne National Lab., IL). pp 181-189 of Scientific basis for nuclear waste management. McCarthy, G.J. (ed.). New York, NY; Plenum Press (1979).

From Annual meeting of Materials Research Society; Boston, MA, USA (28 Nov 1978).

A conceptual flowsheet is presented for encapsulating a ceramic waste form in solid lead, using existing or developing technologies. Unresolved and potential problem areas of the flow sheet are outlined, and suggestions are made on how metal encapsulation might be applied to other solid radioactive wastes from the nuclear fuel cycle. It is concluded that metal encapsulation is a technique

applicable to many forms of solid wastes and is likely to meet future waste isolation criteria and regulations.

2622 Clay-phosphate ceramics and vitromets: alternatives to monolithic high level waste glass products. Zemlyanukhin, V.I.; Kuznetsov, Y.V.; Lazarev, L.N.; Lyubtsev, R.I.; Shashukov, E.A.; Khlopin, V.C. (Radium Institute, Leningrad, USSR). pp 195-200 of Scientific basis for nuclear waste management. McCarthy, G.J. (ed.). New York, NY; Plenum Press (1979).

From Annual meeting of Materials Research Society; Boston, MA, USA (28 Nov 1978).

Some of the results from investigations on high level waste incorporated into ceramic, cermet, and vitromet products are reported.

2623 Synthetic rutile microencapsulation: a radioactive waste solidification system resulting in an extremely stable product. Forberg, S. (Royal Inst. of Tech., Stockholm, Sweden); Westermark, T.; Larker, H.; Widell, B. pp 201-215 of Scientific basis for nuclear waste management. McCarthy, G.J. (ed.). New York, NY; Plenum Press (1979).

From Annual meeting of Materials Research Society; Boston, MA, USA (28 Nov 1978).

Results of the investigations indicate that: using titanate ion exchangers it is feasible to adsorb most of the active species in high level liquid waste; hot isostatic pressing has been successfully employed for crystallization and consolidation of the loaded exchangers; and extremely low radionuclide release rates are indicated by the Soxhlet leaching studies performed so far.

2624 Hot isostatic pressing for the consolidation and containment of radioactive waste. Larker, H.T. (High-Pressure Lab. ASEA AB, Robertsfors, Sweden). pp 207-210 of Scientific basis for nuclear waste management. McCarthy, G.J. (ed.). New York, NY; Plenum Press (1979).

From Annual meeting of Materials Research Society; Boston, MA, USA (28 Nov 1978).

Hot isostatic pressing has been applied for making synthetic mineral blocks from several types of simulated high-level radioactive waste. In addition, a method to make synthetic corundum canisters for spent fuel by a similar technique has been developed. Full scale canisters (0.5 m outside diameter by 3 m) have been made and an irradiated fuel rod has been enclosed successfully in a monolithic half scale synthetic corundum canister.

2625 Raman spectra of cesium aluminosilicate waste forms. Hartwig, C.M. (Sandia Labs., Livermore, CA). pp 219-225 of Scientific basis for nuclear waste management. McCarthy, G.J. (ed.). New York, NY; Plenum Press (1979).

From Annual meeting of Materials Research Society; Boston, MA, USA (28 Nov 1978).

Raman spectra have been obtained from pollucite and similar aluminosilicate materials. Pollucite is used to fix radioactive cesium in the supercalcine reactor waste form and in beneficial-use, radioactive sources. Vibrational modes of Cs in an oxygen atom cage are identified at 141 and 201 cm^{-1}. Stretching vibrations of the Si-O bond are at 1120 cm^{-1} and of the Si-O-Al bond at 1040 cm^{-1}. Fifteen of the 28 Raman active modes of crystalline pollucite have been distinguished. Monomeric water molecules are shown spectroscopically to exist in mineral pollucite. The use of Raman spectroscopy to identify structural changes is demonstrated.

2626 Investigations of the volatility of cesium from aluminosilicates by mass spectrometry. Odoj, R.; Hilpert, K.; Gerads, H. (Kernforschungsanlage, Juelich, Germany). pp 227-229 of Scientific basis for nuclear waste management. McCarthy, G.J. (ed.). New York, NY; Plenum Press (1979).

From Annual meeting of Materials Research Society; Boston, MA, USA (28 Nov 1978).

The different volatility of cesium from the crystalline compounds of the ternary system Cs_2O-Al_2O_3-SiO_2 is demonstrated. Three different crystalline compounds $CsAlSiO_4$, $CsAlSi_2O_6$, and $CsAlSi_5O_{12}$ were found.

2627 Role of admixtures in preparing dense cements for radioactive waste isolation. Roy, D.M.; Daimon, M.; Scheetz, B.E.; Wolfe-Confer, D.; Asaga, K. (Pennsylvania State Univ., University Park). pp 461-466 of Scientific basis for nuclear waste management. McCarthy, G.J. (ed.). New York, NY; Plenum Press (1979).

From Annual meeting of Materials Research Society; Boston, MA, USA (28 Nov 1978).

Sulfonated naphthalene and melamine formaldehyde condensates have been studied as superplasticizing admixtures used to reduce the necessary water content of cement mixes. Their role in producing dense low porosity composites in nuclear waste isolation applications is discussed. Zeta potential, flow, adsorption characteristics, viscosity, setting time and compressive strength data are reported.

2628 Immobilization of strontium and cesium in intermediate-level liquid wastes by solidification in cements. Rudolph, G.; Koester, R. (Kernforschungszentrum, Karlsruhe, Germany). pp 467-470 of Scientific basis for nuclear waste management. McCarthy, G.J. (ed.). New York, NY; Plenum Press (1979).

From Annual meeting of Materials Research Society; Boston, MA, USA (28 Nov 1978).

An accelerated leach test at elevated temperature has been developed which gives intercomparable results within one day. It is very useful for product quality control at large throughputs. Using this test, it has been shown that cesium leachabilities from cement products containing a simulated waste typical of fuel reprocessing plants can be reduced by addition of a bentonite. Addition of barium silicate hydrate retards strontium leaching in these cements. Leach rates in tap water and in salt brine are lower than in distilled water and sodium chloride solution.

2629 Confinement of volatilized ruthenium oxides. Maas, E.T. Jr.; Longo, J.M. (Exxon Research and Engineering Co., Linden, NJ). pp 487-490 of Scientific basis for nuclear waste management. McCarthy, G.J. (ed.). New York, NY; Plenum Press (1979).

From Annual meeting of Materials Research Society; Boston, MA, USA (28 Nov 1978).

Fission product ruthenium poses unique problems in nuclear fuels reprocessing due to the volatility of RuO_4. Results are presented from studies that demonstrate the ability of alkaline earth metal carbonates and calcium oxide to form thermodynamically stable ruthenium compounds and thus fix the volatile ruthenium oxides.

WASTE DISPOSAL AND STORAGE

REFER ALSO TO CITATION(S) 2604, 2612, 2669, 2671, 2672, 2673, 2674, 2678, 2681, 2682, 2683, 2684, 3676

2630 (ALO—0789-T12) **Test results and supporting analysis of a near-surface heater experiment in the Eleana argillite.** McVey, D.F.; Lappin, A.R.; Thomas, R.K. (Sandia Labs., Albuquerque, NM (USA)). 1979. Contract EY-76-C-04-0789. 21p. Dep. NTIS, PC A02/MF A01.

A preliminary evaluation of the in-situ thermomechanical response of argillite to heating was obtained from a near-surface heater test in the Eleana Formation, at the United States Department of Energy, Nevada Test Site. The experiment consisted of a 3.8 kW, 3-m long x 0.3-m diameter electrical heater in a central hole surrounded by peripheral holes containing instrumentation to measure temperature, gas pressures, and vertical displacement. A thermal model of the experiment agreed well with experimental results; a comparison of measured and predicted temperatures indicates that some nonmodeled vertical transport of water and water vapor occurred near the heater, especially at early times. A mechanical model indicated that contraction of expandable clays in the argillite produced a region 1.5 - 2.0 m in radius, in which opening of preexisting joints occurred as a result of volumetric contraction. Results of thermal and mechanical modeling, laboratory property measurements, experimental temperature measurements, and post-test observations are all self-consistent and provide preliminary information on the in-situ response of argillaceous rocks to the emplacement of heat-producing nuclear waste.

2631 (ANL/EES-TM—68) **Review of the nuclear waste disposal problem.** Poch, L.A.; Wolsko, T.D. (Argonne National Lab., IL (USA)). Oct 1979. Contract W-31-109-ENG-38. 18p. Dep. NTIS, PC A02/MF A01.

Regardless of future nuclear policy, a nuclear waste disposal problem does exist and must be dealt with. Even a moratorium on new nuclear plants leaves us with the wastes already in existence and wastes yet to be generated by reactors in operation. Thus, technologies to effectively dispose of our current waste problem must be researched and identified and, then, disposal facilities built. The magnitude of the waste disposal problem is a function of future nuclear policy. There are some waste disposal technologies that are suitable for both forms of HLW (spent fuel and reprocessing wastes), whereas others can be used with only reprocessed wastes. Therefore, the sooner a decision on the future of nuclear power is made the more accurately the magnitude of the waste problem will be known, thereby identifying those technologies that deserve more attention and funding. It is shown that there are risks associated with every disposal technology. One technology may afford a higher isolation potential at the expense of increased transportation risks in comparison to a second technology. Establishing the types of risks we are willing to live with must be resolved before any waste disposal technology can be instituted for widespread commercial use.

2632 (CONF-790420—, pp 349-353) **Iodide and iodate sodalites for the long-term storage of iodine-129.** Strachan, D.M.; Babad, H. (Rockwell Hanford Operations, Richland, WA). May 1979.

From International symposium on ceramics in nuclear waste management; Cincinnati, OH, USA (30 Apr 1979).

There exist several proposals for the storage of ^{129}I. None of these propose the use of a mineral with demonstrated geologic stability. The work described in this paper has identified the minerals iodide and iodate sodalites $[Na_8(AlSiO_4)_6I_2/(IO_3)_2]$ as good candidates for the long-term storage of ^{129}I. 4 tables.

2633 (DOE/EV—0046(Vol.2), pp 259-272) **Technical program for establishing the scientific basis for geologic disposal.** Heineman, R.E.; Carbiener, W.A.; Basham, S.J. (Battelle Memorial Inst., Columbus, OH). Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

Work performed to date on characterization of geologic media, design of repositories and support facilities, and safety assessments of geologic isolation have provided an understanding of the important variables in the technology required. Reviews of this work by technical peer groups and by DOE, as well as an evaluation by an Interagency Review Group during 1978, have provided additional insights into the requirements for basic scientific data, engineering development, and systems modeling that should be developed or augmented to accomplish the goals of the NWTS program. The DOE and its major contractors in the program are responding to these identified needs by utilizing the resources of the US Geological Survey, universities, national laboratories, and industry in a coordinated program to characterize the properties of promising geologic and hydrologic regimes, to obtain basic scientific knowledge of the effects of heat-producing waste forms on the geochemistry and rock mechanics aspects of the media, to extend the programs of testing and model validation from salt to other candidate media such as granite and basalt, and to prepare a consolidated conceptual design to assess the safety and reliability of operation under normal and abnormal conditions. These programs will be guided by licensing plans which define how and when the data obtained will be utilized in reports on various topics important to the assessment of the short- and long-term safety of the repository. Design and licensing criteria are available, in part, and the remainder are being developed by DOE in parallel with a similar effort by the Environmental Protection Agency and the Nuclear Regulatory Commission. These on-going and planned NWTS programs will be described.

2634 (DP-MS--79-37) **Temperatures generated by underground storage of defense waste canisters.** Tennant, M.H. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Plant). 1979. Contract EY-76-C-09-0001. 9p. (CONF-791112—11). Dep. NTIS, PC A02/MF A01.

From Symposium on the scientific basis for nuclear waste management; Boston, MA, USA (26 Nov 1979).

For conditions conducive to leaching, i.e., moisture in contact with glass, the glass surface temperature would essentially be the canister cavity temperature because temperature rises across wet annuli are small. In turn, canister cavity temperatures are dominated by canister spacing for a given canister power and decay curve. Actual canister powers may be as much as 40% less than those used for these calculations. For dry salt in contact with the storage container, the temperature rises across the annuli may be large. The container temperature would tend to peak earlier for dry annuli than for wet annuli. When canister cavity temperatures peak, salt temperatures would be increased over normal approximately 500 feet in any direction extending from the repository. 5 figures.

2635 (LA—7974-PR) **Research and development related to Nevada nuclear waste storage investigations. Progress report, April 1-June 30, 1979.** Wolfsberg, K. (comp.). (Los Alamos Scientific Lab., NM (USA)). Aug 1979. Contract W-7405-ENG-36. 14p. Dep. NTIS, PC A02/MF A01.

Geochemical laboratory support for Subtask 3.2.2, Tuff Media Investigations; geologic support for Subtask 2.5, Tectonics, Seismicity, and Volcanism; and administrative support for Subtask 5.2, Quality Control are presented. Mineralogic-petrologic examination of material from Yucca Mountain hole UE25A#1 is nearing completion. Sorption measurements on tuff from holes J-13 and UE25A#1 are continuing with both natural and synthetic ground waters and under aerobic and anoxic conditions. Column work is continuing. A standardized batch procedure for Am and Pu has been adopted. A preliminary probability analysis has been performed for volcanic hazards of the Crater Flats basalts.

2636 (LBL—7089) **Very deep hole concept: evaluation of an alternative for nuclear waste disposal.** O'Brien, M.T.; Cohen, L.H.; Narasimhan, T.N.; Simkin, T.L.; Wollenberg, H.A.; Brace, W.F.; Green, S.; Pratt, H.P. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.; Terra Tek, Inc., Salt Lake City, UT (USA)). Jul 1979. Contract W-7405-ENG-48. 56p. Dep. NTIS, PC A04/MF A01.

One proposal for disposing of radioactive waste is to put it in drill holes or mined cavities so deep that the waste would be effectively isolated from the surface. Even if radioisotopes escaped from the disposal canister, they would be removed from the circulating groundwater system by sorption and/or chemical reaction in their transit on very long paths to the surface. This report summarizes the feasibilities and costs of making deep holes and deep mine shafts; estimates probable technological advances by the year 2000; presents thermal history and thermally induced stress calculations based on several assumptions regarding age of waste and density of emplacement; and summarizes lack of knowledge that bear upon the isolation of waste at great depth. In strong rock, present technology would probably enable us to drill a hole 20 cm in diameter to a depth of 11 km and sink a shaft 10 m in diameter to about 4.4 km. By the year 2000, with advancement of technology, holes of 15 km depth and 20 cm diameter could be drilled, and shafts of 6.4 km or deeper could be sunk. The heat output of 5.5-year-old spent fuel and 6.5-year-old reprocessed waste is used to calculate temperature increases and stress buildings in the surrounding rocks. Some waste configurations may cause unacceptably high temperature increases; indeed, limitations on temperatures reached will in some cases limit the packing density of waste canisters and/or require longer cooling of the waste before emplacement. Sealing boreholes and shafts for significant times, i.e. 1,000 to 100,000 years presents additional problems. The casing or ling of the borehole or shaft would have to be removed in the region where seals are constructed, or the lining material would have to be designed to function as an integral part of the long-term seal. Sealing fractures in the rock around the borehole or shaft will be quite important.

2637 (PNL—2776) **Naturally occurring glasses: analogues for radioactive waste forms.** Ewing, R.C.; Haaker, R.F. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Apr 1979. Contract EY-76-C-06-1830. 82p. Dep. NTIS, PC A05/MF A01.

Volcanic glasses are very often altered by weathering and leaching and recrystallize to their fine-grained equivalents (rhyolites, felsites). The oldest volcanic glasses are dated at 40 million years before the present, but the majority are much younger. Devitrification textures was produced experimentally; and hydration rates for volcanic glasses were determined as a function of composition, temperature, and climate. Presence of water and temperature are the most important rate controlling variables. Even material that may still be described as glassy often exhibits evidence of alteration and recrystallization. Of the volcanic glasses that are preserved in the geologic record, it would be rare to describe such a glass as pristine. Despite the common alteration and recrystallization effects observed in volcanic glasses, glasses formed as a result of impact, tektites and lunar glasses, may occur in substantially unaltered form. In the case of tektites, their resistance to alteration is a result of their high SiO_2 content and low alkali content. Lunar glasses have been preserved for hundreds of millions of years because they exist in an environment with a low oxygen fugacity and an extremely low water vapor partial presssure. Thus one might expect glasses of particular compositions or in specific types of environment to be stable for long periods of time. These conclusions are applied to radioactive waste disposal over several time periods (0-30h, 30h-20y, 20-200y).

2638 (RHO-SA—143) **Real-time monitoring of Hanford nuclear waste.** McNeece, S.G.; Glasscock, J.A.; Rosnick, C.K. (Rockwell International Corp., Richland, WA (USA). Rockwell Hanford Operations). Oct 1979. Contract EY-77-C-06-1030. 19p. Dep. NTIS, PC A02/MF A01.

Two minicomputers are used to perform real time monitoring of radioactive waste storage tanks on the Hanford Nuclear Reservation. The Computer Automated Surveillance System, CASS, consists of a network of six field microprocessors, a central microprocesor and two central Eclipse minicomputers. The field microprocessors are each responsible for monitoring alarm sensors, liquid levels and temperatures. The field microprocessors report alarm conditions immediately to the central microprocessor. The central minicomputer reports all alarm conditions to the user terminals, requests data from the field on a scheduled and requested basis, and generates reports. It handles all requests for information from the user and stores all incoming data for historical purposes. The CASS software consists of five major segments: (1) process creation, (2) report generation, (3) file updating, (4) terminal communication, and (5) microprocessor communication. Since CASS must operate 24 hours a day, 7 days a week, the system cannot be allowed to abnormally terminate. For this reason all processes are started by the creation process. Having a single process responsible for creating all other processes provides the ability to detect a failure of a subordinate process and to automatically restart the failed process. The report generation process schedules reports, requests the data to be gathered to produce the reports, forms the reports, and distributes the reports to the user terminals. The file updating process handles all data file modifications. There is a terminal communication process for each user terminal which is responsible for printing scheduled reports and for allowing the user to request information from the CASS system. The microprocessor communication process handles all communication with the central microprocessor.

2639 (RHO-ST—23) **Geology of the Separation Areas, Hanford site, South-Central Washington.** Tallman, A.M.; Fecht, K.R.; Marratt, M.C.; Last, G.V. (Rockwell International Corp., Richland, WA

(USA). Rockwell Hanford Operations). Jun 1979. Contract EY-77-C-06-1030. 204p. Dep. NTIS, PC A10/MF A01.

The major geologic units beneath the Separation Areas are: basement rocks of undetermined origin, the Columbia River Basalt Group with intercalated sediments of the Ellensburg Formation, the Ringold Formation, and the glaciofluvial sediments (Hanford Formation). A loess deposit (early Palouse soil) occurs between the Ringold and Hanford formations in parts of 200 West Area. The surface of the Separation Areas is veneered with loess and sand dunes of varying thickness. The sediments of the Hanford Formation are the most significant geologic unit in the transport and sorption of radionuclides from surface and near surface waste storage facilities. The Hanford sediments in the Separation Areas effectively isolate and sorb most radiocontaminants (half life greater than one year) discharged to or stored in the ground due to a thick sequence of unsaturated sediments with an adequate sorption capacity. The general horizontal bedding of the Hanford sediments promotes lateral spreading of moisture and retards downward transport of radionuclides.

2640 (SAND—79-0895C) **Probabilistic aspects of faulting in anisotropic media.** Cranwell, R.M.; Donath, F.A. (Sandia Labs., Albuquerque, NM (USA); Illinois Univ., Urbana (USA)). 1979. Contract EY-76-C-04-0789. 8p. (CONF-791112—6). Dep. NTIS, PC A02/MF A01.

From Symposium on the scientific basis for nuclear waste management; Boston, MA, USA (26 Nov 1979).

The potential is estimated for new faults occurring and intersecting a radwaste repository. In-situ stress measurements and seismic activity records are needed. (DLC)

2641 (SAND—79-1013C) **Far field thermal calculations for the WIPP site in SENM.** Pahwa, S.B.; Wayland, J.R. (INTERA Environmental Consultants, Inc., Houston, TX (USA); Sandia Labs., Albuquerque, NM (USA)). Oct 1979. Contract EY-76-C-04-0789. 20p. (CONF-791112—14). Dep. NTIS, PC A02/MF A01.

From Symposium on the scientific basis for nuclear waste management; Boston, MA, USA (26 Nov 1979).

This idealized study indicates that there is little impact upon the far thermal field from water expansion or for stoppage of aquifer flow. The variability of salt thermal conductivity in the Salado Formation can be as important to the magnitude of the temperature fields as the extremes proposed for thermal loading densities. 5 figures, 3 tables.

2642 (SAND—79-1197C) **Sensitivity study on the parameters of the regional hydrology model for the Nevada nuclear waste storage investigations.** Iman, R.L.; Davenport, J.M.; Waddell, R.K.; Stephens, H.P.; Leap, D.I. (Sandia Labs., Albuquerque, NM (USA); Texas Tech Univ., Lubbock (USA); Geological Survey, Denver, CO (USA)). 1979. Contract EY-76-C-04-0789. 31p. (CONF-791016—3). Dep. NTIS, PC A03/MF A01.

From 1979 DOE statistical symposium; Gatlinburg, TN, USA (24 Oct 1979).

Statistical methodology has been applied to the investigation of the regional hydrologic systems of a large area encompassing the Nevada Test Site (NTS) as a part of the overall evaluation of the NTS for deep geologic disposal of nuclear waste. Statistical techniques including Latin hypercube sampling were used to perform a sensitivity analysis on a two-dimensional finite-element code of 16 geohydrologic zones used to model the regional ground-water flow system. The Latin hypercube sample has been modified to include correlations between corresponding variables from zone to zone. From the results of sensitivity analysis it was found that: (1) the ranking of the relative importance of input variables between locations within the same geohydrologic zone were similar, but not identical; and (2) inclusion of a correlation structure for input variables had a significant effect on the ranking of their relative importance. The significance of these results is discussed with respect to the hydrology of the region.

2643 (USGS-OFR—79-1244) **Preliminary report on the geology and geophysics of drill hole UE25a-1, Yucca Mountain, Nevada Test Site.** Spengler, R.W.; Muller, D.C.; Livermore, R.B. (Geological Survey, Denver, CO (USA); Fenix and Scisson, Inc., Mercury, NV (USA)). 1979. Contract EW-78-I-08-1543. 80p. Dep. NTIS, PC A05/MF A01.

A subsurface geologic study in connection with the Nevada Nuclear Waste Storage Investigations has furnished detailed stratigraphic and structural information about tuffs underlying northeastern Yucca Mountain on the Nevada Test Site. Drill hole UE25a-1 penetrated thick sequences of nonwelded to densely welded ash-flow and bedded tuffs of Tertiary age. Stratigraphic units that were identified from the drill-hole data include the Tiva Canyon and Topopah Spring Members of the Paintbrush Tuff, tuffaceous beds of Calico Hills, and the Prow Pass and Bullfrog Members of the Crater Flat Tuff. Structural analysis of the core indicated densely welded zones to be highly fractured. Many fractures show near-vertical inclinations and are commonly coated with secondary silica, manganese and iron oxides, and calcite. Five falt zones were recognized, most of which occurred in the Topopah Spring Member. Shear fractures commonly show oblique-slip movement and some suggest a sizable component of lateral compression. Graphic logs are included that show the correlation of lithology, structural properties, and geophysical logs. Many rock units have characteristic log responses but highly fractured zones, occurring principally in the Tiva Canyon and Topopah Spring Members restricted log coverage to the lower half of the drill hole.

2644 **Helium formation from α-decay and its significance for radioactive waste glasses.** Malow, G.; Andresen, H. (Hahn-Meitner-Institut fuer Kernforschung, Berlin, Germany). pp 109-115 of Scientific basis for nuclear waste management. McCarthy, G.J. (ed.). New York, NY; Plenum Press (1979).

From Annual meeting of Materials Research Society; Boston, MA, USA (28 Nov 1978).

To produce high radiation damage and excessive helium concentrations, the $^{10}B(n,\alpha)^{7}Li$ nuclear reaction was applied to a zinc-borosilicate glass. The number of displaced atoms could be estimated by using a collision model. The fraction of displaced atoms in glasses containing actinide elements was calculated to be orders of magnitude larger from α-decay than from β,γ-decay and spontaneous fission. Helium diffusion was measured between ~ 120 and ~ 650° and was found to be dependent upon the α-dose up to 500°C. The activation enthalpy increased from 79 to 111 kJ/mole when the α-dose rose from 10^{17} to 10^{19} per cm^3. The activation enthalpy as a function of the number of displacements per atom (dpa) revealed a saturation at about 0.1 dpa. At higher temperatures the diffusion dependency upon the α-dose disappeared and the activation enthalpy was 45 kJ/mole. With respect to the long-term situation, the above results gave evidence that helium will remain in the waste glass and a saturation of radiation damage will only be reached after some ten thousand years.

2645 **Chemistry of nuclear waste glass reactions: problems and potential of prediction.** Adams, P.B. (Corning Glass Works, NY). pp 123-129 of Scientific basis for nuclear waste management. McCarthy, G.J. (ed.). New York, NY; Plenum Press (1979).

From Annual meeting of Materials Research Society; Boston, MA, USA (28 Nov 1978).

Many commonly accepted principles of glass corrosion testing can lead to false conclusions if they are accepted as generalities. It is essential to recognize the effects of changing chemistry in test solutions, of temperature on reaction rates, of cycling conditions and of anomalous reactions. One then concludes that simulation modeling is essential, that better standard tests are needed, that wet site disposal may be a good choice and that anomalous failure can be avoided by proper glass design.

2646 **Characterization of leached surface layers on simulated high-level waste glasses by sputter-induced optical emission.** Houser, C.; Tsong, I.S.T.; White, W.B. (Pennsylvania State Univ., University Park, PA). pp 131-139 of Scientific basis for nuclear waste management. McCarthy, G.J. (ed.). New York, NY; Plenum Press (1979).

From Annual meeting of Materials Research Society; Boston, MA, USA (28 Nov 1978).

The leaching process in simulated waste encapsulant glasses was studied by measuring the compositional depth-profiles of H (from water), the glass framework formers Si and B, the alkalis Na and Cs, the alkaline earths Ca and Sr, the transition metals Mo and Fe, the rare-earths La, Ce, and Nd, using the technique of sputter-induced optical emission. The leaching process of these glasses is highly complex. In addition to alkali/hydrogen exchange, there is breakdown of the glass framework, build-up of barrier layers on the surface, and formation of layered reaction zones of distinctly different chemistry all within the outer micrometer of the glass.

2647 **Leach rate characterization of solid radioactive waste forms.** Flynn, K.F.; Barletta, R.E.; Jardine, L.J.; Steindler, M.J. (Argonne National Lab., IL). pp 149-155 of Scientific basis for nuclear waste management. McCarthy, G.J. (ed.). New York, NY; Plenum Press (1979).

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Leach rates for a number of proposed radioactive waste forms have been measured. A neutron activation analysis technique has been used exclusively for these measurements. Leach rates as low as 10^{-9} g/cm^2d were easily determined. Problems associated with surface area determination, sample preparation and data interpretation are discussed.

2648 **Calculations of radioactivity release due to leaching of vitrified high level waste.** Ewest, E. (Hahn-Meitner-Institut fuer Kernforschung, Berlin, Germany). pp 161-168 of Scientific basis for nuclear waste management. McCarthy, G.J. (ed.). New York, NY; Plenum Press (1979).

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A model is presented for the calculation of radioactivity release from vitrified waste. The calculation is demonstrated for a borosilicate glass block which has been assumed to be exposed to water for 1,000,000 years. How far this model can be used in safety studies on the final disposal of vitrified waste in a geologic repository is discussed.

2649 Pollucite and its alteration in geological occurrences and in deep-burial radioactive waste disposal. Cerny, P. (Univ. of Manitoba, Winnipeg). pp 231-236 of Scientific basis for nuclear waste management. McCarthy, G.J. (ed.). New York, NY; Plenum Press (1979).

From Annual meeting of Materials Research Society; Boston, MA, USA (28 Nov 1978).

The properties, occurrences, and alterations of natural pollucite are reviewed. Four general conclusions may be derived from the geological history of pollucite, and from the scanty experimental work, which may help to predict the behavior of the synthetic ^{137}Cs-based pollucite in deep-burial waste storage: natural pollucite phases show a wide range of Cs/Na ratios, and laboratory synthesis produced isomorphous compounds with substantial K, Rb, Ca, Sr, and several other cations. The rarity, specialized paragenesis, and limited conditions of formation of natural pollucite and cesian analcime are caused much more by geochemical scarity and migration pattern of Cs rather than by their restricted stability. The wide variety of alteration products replacing natural pollucite indicates easy breakdown under diverse conditions. Natural alteration of pollucite invariably leads to efficient dispersal of the released Cs.

2650 Sciontific basis for, and experience with, underground storage of liquid radioactive wastes in the USSR. Spitsyn, V.I.; Balukova, V.D. (Inst. of Physical Chemistry, Moscow, USSR). pp 237-248 of Scientific basis for nuclear waste management. McCarthy, G.J. (ed.). New York, NY; Plenum Press (1979).

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Factors considered in the selection of deep absorbing horizons (strata collectors) for underground storage of liquid wastes are given. The pretreatment of wastes and processes occurring in the strata collector are discussed. All the aspects discussed have been verified in actual underground storage installations. The methodology for prediction of sorption and migration behavior of radionu-.lides, for evaluation of the heat field in the stratum and for radiolysis processes and their influence on the storage of liquid wastes in strata collectors was confirmed.

2651 Influence of radiation on the system liquid radioactive wastes: geologic formation. Spitsyn, V.I.; Balukova, V.D.; Kabakchi, S.A.; Medvedeva, M.L. (Institute of Physical Chemistry, Moscow, USSR). pp 249-255 of Scientific basis for nuclear waste management. McCarthy, G.J. (ed.). New York, NY; Plenum Press (1979).

From Annual meeting of Materials Research Society; Loston, MA, USA (28 Nov 1978).

Introduction of liquid radioactive wastes into deep strata-collectors results in a number of physical-chemical processes: precipitation, dissolution, complex formation, sorption, etc. The area occupied by the injected waste and changes in the nature of the liquid phase depend primarily on radiolysis processes in the heterogeneous system of liquid waste-stratal material occurring at elevated temperatures and pressures. Experiments that simulate actual conditions of temperature, pressure and high radiation levels on this system have been performed. Results are presented for radiolytic gas formation and for changes in the liquid phase and sorption capacity of stratal minerals. It is shown that the temperature increase in the stratum-collector significantly enhances waste decomposition processes, promotes sorption of radionuclides and decreases the mobility of the waste in the formation.

2652 Rock-melt approach to nuclear waste disposal in geological media. Cohen, J.L.; Steinborn, T.L. (Lawrence Livermore Lab., CA). pp 261-264 of Scientific basis for nuclear waste management. McCarthy, G.J. (ed.). New York, NY; Plenum Press (1979).

From Annual meeting of Materials Research Society; Boston, MA, USA (28 Nov 1978).

An unconventional method for geologic disposal of nuclear waste has been proposed which uses decay heat for beneficial purposes. This is the rock-melt concept which calls for the direct addition of high-level waste either in solution or slurry form into a deep mined cavity in silicate rock. Following the period of waste addition, the cavity is allowed to boil dry. Subsequently, the decay heat melts the waste and the surrounding rock. The molten rock dissolves the waste and the molten mixture grows, reaching its maximum radius in times typically estimated at tens to hundreds of years. When the rate of conductive heat loss from the system exceeds that of heat input from radioactive decay, the system begins to cool and solidify. Total resolidification could require several centuries. During that period, fission products will have essentially decayed away, leaving the actinide components. The ultimate result would be the encapsulation of this radioactive material in a relatively insoluble rock matrix deep underground.

2653 Interaction of a glass-based nuclear waste simulant and natural rock. Hlava, P.F.; Chambers, W.F. (Sandia Labs., Albuquerque, NM). pp 265-270 of Scientific basis for nuclear waste management. McCarthy, G.J. (ed.). New York, NY; Plenum Press (1979).

From Annual meeting of Materials Research Society; Boston, MA, USA (28 Nov 1978).

The basic experiment consisted of inserting a simulant glass containing stable isotopes in a hole bored into a 0.9 m x 0.9 m x 1.4 m block of microgabbro. Electron microprobe analysis provided significant information about the convection behavior and waste-rock interactions that occurred during the experiment. Results of this investigation are summarized.

2654 Corrosion resistance of canisters for final disposal of spent nuclear fuel. Mattsson, E. (Swedish Corrosion Inst., Stockholm). pp 271-281 of Scientific basis for nuclear waste management. McCarthy, G.J. (ed.). New York, NY; Plenum Press (1979).

From Annual meeting of Materials Research Society; Boston, MA, USA (28 Nov 1978).

A group of Swedish scientists has evaluated from the corrosion point of view three alternative canister types for final disposal of waste from nuclear reactors in boreholes in rock 500 m below ground. Titanium canisters with a wall-thickness of 6 mm and 100 mm thick lead lining have been estimated to have a life of at least thousands of years, and probably tens of thousands of years. Copper canisters with 200-mm-thick walls would last for hundreds of thousands of years. The third type, α-alumina sintered under isostatic pressure, is a very promising canister material.

2655 Preliminary corrosion test of a glass-ceramic candidate for a nuclear waste canister. Sundquist, J.D. (Corning Glass Works, NY). pp 289-296 of Scientific basis for nuclear waste management. McCarthy, G.J. (ed.). New York, NY; Plenum Press (1979).

From Annual meeting of Materials Research Society; Boston, MA, USA (28 Nov 1978).

Preliminary corrosion studies of Corning Glass Works glass-ceramic Code 9617 as a storage canister for spent nuclear fuel rods indicates a corrosion rate of 0.013 cm/1000 y when stored in a granite repository at an initial temperature of 110°C. This is well within the targeted rate of 0.1 cm/1000 y.

2656 Application of physical chemistry of fluids in rock salt at elevated temperature and pressure to repositories for radioactive waste. Stewart, D.B. (Geological Survey, Reston, VA); Potter, R.W. pp 297-311 of Scientific basis for nuclear waste management. McCarthy, G.J. (ed.). New York, NY; Plenum Press (1979).

From Annual meeting of Materials Research Society; Boston, MA, USA (28 Nov 1978).

The compositions of natural brines are described; some limits are set on their compositions and physical properties under repository conditions; and the nature and implications of the freezing-point depressions in polycomponent systems such as are likely to occur in salt repositories are discussed.

2657 Application of studies of fluid inclusions in Permian Salado salt, New Mexico, to problems of siting the Waste Isolation Pilot Plant. Roedder, E.; Belkin, H.E. (Geological Survey, Reston, VA). pp 313-321 of Scientific basis for nuclear waste management. McCarthy, G.J. (ed.). New York, NY; Plenum Press (1979).

From Annual meeting of Materials Research Society; Boston, MA, USA (28 Nov 1978).

The data obtained when inclusions in cores from the proposed WIPP site were examined pettrographically, and with microscope freezing, heating, and crushing stages are summarized. Fluid now present in the samples studied ranges widely from $<$ 0.1 to 1.7 wt %; the total in situ fluid content of the rock is certainly greater. The inclusion fluid is not just saturated NaCl solution but a variable and extremely saline bittern containing some noncondensable gases under pressure. The inclusions move in thermal gradients and react quickly to uniaxial stress, but decrepitation is estimated to be a more important mechanism of fluid release under thermal loading. Subsequent movement of the released fluids is not considered.

2658 P-T-X relations of anhydrite and brine and their implications for the suitability of anhydrite as a nuclear waste repository medium. Clynne, M.A.; Potter, R.W. II. (Geological Survey, Menlo Park, CA). pp 323-328 of Scientific basis for nuclear waste management. McCarthy, G.J. (ed.). New York, NY; Plenum Press (1979).

From Annual meeting of Materials Research Society; Boston, MA, USA (28 Nov 1978).

The solubility properties of anhydrite indicate that it could serve as a suitable repository medium. The solubility of $CaSO_4$ has been confirmed to remain low despite the high activity of chloride ions. At 200°C the solubility of anhydrite in saturated NaCl solutions (0.0205 molal) is approximately 3.9×10^2 times less soluble than Nacl. (8.014 molal). In addition, the solubility of anhydrite in NaCl-saturated water exhibits a negative temperature coefficient up to 235 +- 20°C. We have shown that the solubility of anhydrite in NBT-6, a synthetic bittern, is significantly less than in NaCl-saturated water,

and that its negative temperature coefficient persists to higher temperatures (250 +- 20°C). Consequently, fluid inclusions will migrate down a thermal gradient, i.e., away from radioactive waste containers. The suitability of anhydrite as a repository medium is further enhanced by its thermal conductivity; its favorable occurrence in evaporite basins; and its generally low fluid inclusion content (commonly lower than halite). Anhydrite could also be employed as an overpack in a salt repository to help protect the canisters from the brines mobilized by the thermal pulse.

2659 Hydrothermal reactivity of simulated nuclear waste forms and water-catalysed waste-rock interactions. McCarthy, G.J.; Komarneni, S.; Scheetz, B.E.; White, W.B. (Pennsylvania State Univ., University Park, PA). pp 329-340 of Scientific basis for nuclear waste management. McCarthy, G.J. (ed.). New York, NY; Plenum Press (1979).

From Annual meeting of Materials Research Society; Boston, MA, USA (28 Nov 1978).

Hydrothermal interactions of three waste forms (spent fuel, a glass, and a crystalline ceramic) and three repository rock types (basalt, shale, and salt) are considered. The results presented illustrate three types of hydrothermal waste-rock interactions experimentation: reactivity of waste forms in the presence of aqueous solutions; reactivity among waste, rock, and water; and mechanistic studies of potentially important radionuclide fixation reactions. It was shown that if pressurized water should contact nuclear waste during the thermal period of a geologic repository, alteration of the waste and waste-rock interactions can occur. Prototype waste materials react to various degrees in the presence of groundwater. At 300°C glass is altered and devitrified with some elements being extracted into solution. The synthetic minerals of crystalline ceramics show little reaction. The UO_2 matrix of spent fuel shows very little reaction but some fission products can be dissolved. All three waste forms are very reactive with bittern brines. It should be emphasized that alteration of the more reactive waste forms does not necessarily lead to massive releases of radioactivity away form the repository. With certain classes of repository rocks, waste-rock interactions could lead to the formation of new mineral-like phases that could be far more stable in the long term than was the original waste form.

2660 Hydrothermal glass reactions in salt brine. Westsik, J.H. Jr.; Turcotte, R.P. (Battelle Pacific Northwest Labs., Richland, WA). pp 341-344 of Scientific basis for nuclear waste management. McCarthy, G.J. (ed.). New York, NY; Plenum Press (1979).

From Annual meeting of Materials Research Society; Boston, MA, USA (28 Nov 1978).

A simulated high-level waste glass was exposed to high-temperature salt brine and deionized water. The glass undergoes partial crystallization, depending on the conditions, and yields $NaFeSi_2O_6$ as the primary alteration product. At the extreme temperature of these tests, cesium, rubidium, strontium and molybdenum show moderate-to-high solubilities in salt brine. Solubility in deionized water is an order of magnitude lower than in salt brine, but the glass alteration rate is higher. In a similar salt brine test, a supercalcine showed similar cesium and strontium releases when compared to the glass.

2661 Radiation damage studies on natural and synthetic rock salt for waste disposal applications. Swyler, K.J.; Klaffky, R.W.; Levy, P.W. (Brookhaven National Lab., Upton, NY). pp 349-354 of Scientific basis for nuclear waste management. McCarthy, G.J. (ed.). New York, NY; Plenum Press (1979).

From Annual meeting of Materials Research Society; Boston, MA, USA (28 Nov 1978).

Natural rock salt and synthetic NaCl develop negative ion defects (F centers) when irradiated between 20 and 300°C. Both form high concentrations of sodium metal colloid particles when irradiated in the 125 to 200°C region. Based on the current data, it is estimated that the exposures expected from high-level waste disposal canister will cause 0.01 to 0.1 mole percent of the sodium in the surrounding rock salt to be converted to sodium metal colloid particles. Defect formation is dependent on temperature, crystal strain, dose, dose rate, origin of crystals and possibly other factors.

2662 Thermodynamic considerations underlying the migration of radionuclides in geomedia: Oklo and other examples. Brookins, D.G. (Univ. of New Mexico, Albuquerque). pp 355-366 of Scientific basis for nuclear waste management. McCarthy, G.J. (ed.). New York, NY; Plenum Press (1979).

From Annual meeting of Materials Research Society; Boston, MA, USA (28 Nov 1978).

The prediction of migration or retention of radionuclides in geomedia is one of the major problems associated with radioactive waste disposal. Use of Eh-pH diagrams based on sound thermodynamic data has proven useful for both the Oklo Natural Reactor and for sedimentary uranium deposits. Appropriate diagrams for temperatures in the range from 25 to 200°C allow predictions to be made which are entirely consistent with available measurements. For geomedia where organics are present and for brines, experimental data must be employed to supplement any predictions made on a purely inorganic thermodynamic data base.

2663 Measurements of parameters essential to predicting nuclide migration. Fried, S.; Friedman, A.; Schreiner, F.; Sjoblom, R.; Hines, J.; Strickert, R.; Rickert, P. (Argonne National Lab., IL). pp 367-377 of Scientific basis for nuclear waste management. McCarthy, G.J. (ed.). New York, NY; Plenum Press (1979).

From Annual meeting of Materials Research Society; Boston, MA, USA (28 Nov 1978).

In order to determine the gross rate of migration of radionuclides in rocks the movement of radioactive traces through hornblende schists and through Bandelier tuff was studied. The results of the measurements of tracer mobilities in tuff and hornblende schist demonstrate that the gross flow rate is not a simple parameter. In addition to the measurement of migration rates, experiments were begun to determine the long-term stable valence states of actinide elements. The valence state is a significant parameter governing the chemical interaction of migrating species with the environment. In the case of nuclides such as uranium, plutonium, and neptunium, which can exist in oxidation states varying from 3 to 6, the most stable configuration will be determined by the redox potential of the surrounding medium. In order to predict the behavior of these nuclides it is necessary not only to predict the behavior of these that will ultimately be stable but also the rates of conversion from other oxidation states. Optical spectroscopy was chosen as a convenient means for monitoring the valence states. Preparation of the spectroscopic samples is discussed.

2664 Interaction of waste radionuclides with geomedia; program approach and progress. Relyea, J.F.; Rai, D.; Serne, R.J. (Battelle Pacific Northwest Labs., Richland, WA). pp 379-394 of Scientific basis for nuclear waste management. McCarthy, G.J. (ed.). New York, NY; Plenum Press (1979).

From Annual meeting of Materials Research Society; Boston, MA, USA (28 Nov 1978).

The Waste Isolation Safety Assessment Program (WISAP) approach is discussed. The data for formation-dissolution of solid phases of the radionuclides and adsorption and exchange of radionuclides by the geomedia are needed for determining radionuclide-geomedia interactions. In order to evaluate the effect of formation and dissolution of minerals and precipitates on solution composition and concentration, the available thermodynamic data were summarized. From these data, solid phase and solution species diagrams were developed to predict the most stable solid and solution phases and the radionuclide concentrations at equilibrium with them in different environments. Computer codes are being developed or modified to handle the thermodynamic data to (i) avoid repetitive calculations by hand and (ii) allow easy modification or inclusion of new data. Solubility isotherms of different elements for a few selected minerals will also be generated. Kinetic effects are ignored in thermodynamic calculations. If the reaction kinetics can be ignored, these calculations should be valid for the required isolation period. Some of the problems that have been encountered in carrying out this problem are discussed. Data analysis and validation techniques are covered.

2665 Radionuclide migration studies associated with the WIPP site in southern New Mexico. Dosch, R.G. (Sandia Labs., Albuquerque, NM). pp 395-398 of Scientific basis for nuclear waste management. McCarthy, G.J. (ed.). New York, NY; Plenum Press (1979).

From Annual meeting of Materials Research Society; Boston, MA, USA (28 Nov 1978).

Sorption coefficients (Kd's) were determined by batch contacting $\leqq$ 74 μm particles of rock or non-halite minerals or a 350 to 840 μm particle range of halite minerals with solutions doped at 1 μCi/ml or less with ^{137}Cs, ^{85}Sr, ^{131}I, ^{144}Ce, ^{125}Sb, ^{99}Tc, ^{152}Eu, ^{153}Gd, ^{106}Ru, ^{243}Am, ^{244}Cm, or ^{238}Pu. Samples of the liquid phase were taken through 0.8 μm filters after periods of 14 to 20 days and 30 to 35 days for the fission products and 170 days for the actinides. A general summation of the Kd results in brine simulants is as follows. Anionic species, pertechnetate and isodide, showed little or no tendency to sorb on any of the samples (Kd $<$ 1), with the possible exception of a clay from a halite stratum (Kd $<$ 5); cesium and strontium Kd's were also generally less than 1, but values in the range of 10 to 20 were observed on several minerals; ruthenium Kd's were in the range 2540 $>$ 1000, depending on the brine and the geomedia; the actinide and lanthanide Kd's were typically $>$ 1000, with only polyhalite showing significantly lower sorption; in the ground water simulant, pertechnetate and iodine showed the same behavior; and the Kd's of the other nuclides were slightly higher, particularly those of cesium and strontium.

2666 Variables affecting sorption and transport of radionuclides in Hanford subsoils. Barney, G.S. (Rockwell Hanford Operations, Richland, WA). pp 435-438 of Scientific basis for nuclear waste management. McCarthy, G.J. (ed.). New York, NY; Plenum Press (1979).

From Annual meeting of Materials Research Society; Boston, MA, USA (28 Nov 1978).

Factors initially considered to control radionuclide sorption on Hanford sediments are: waste composition, groundwater components, sediment characteristics, chemical species of radionuclides, temperature, and time. Ten variables selected for study in the screening experiments were: Na^+, K^+, Ca^{2+}, Mg^{2+}, No_3^-, NO_2^-, SO_4^{2-}, humic acid concentrations, sediment particle size, and source. The radionuuclides chosen for study were ^{137}Cs, ^{85}Sr, ^{99}Tc, ^{60}Cs, and ^{106}Ru. Sediments were obtained from four different well cores. Variables which were found to significantly affect sorption of ^{137}Cs are K^+, Na^+, humic acid, and sediment source. For ^{85}Sr the variables are Ca^{2+}, Na^+, humic acid, and Mg^+; for ^{60}Co they are NO_3^-, humic acid, and K^+; and for ^{106}Ru they are NO_3^-, humic acid, and Ca^{2+}. None of the variables had a detectable effect on ^{99}Tc sorption.

2667 Permeability measurements on cementitious material for nuclear waste isolation. White, E.L.; Scheetz, B.E.; Roy, D.M.; Zimmerman, K.G.; Grutzeck, M.W. (Pennsylvania State Univ., University Park). pp 471-478 of Scientific basis for nuclear waste management. McCarthy, G.J. (ed.). New York, NY; Plenum Press (1979).

From Annual meeting of Materials Research Society; Boston, MA, USA (28 Nov 1978).

Gas and liquid permeability measurement methods have been developed and utilized for characterization of cement composites and rocks for application to nuclear waste geologic repository problems. Permeabilities in the millidarcy to tens of nanodarcys range have been measured reproducibly and are related to problems of borehole plugging and shaft sealing.

2668 Comparison of some geologic and ocean disposal concepts regarding realistic modeling that allows objective risk assessment to be made. Nielsen, S.O. (Symplexor Engineering Consultants, Inc., Holte, Denmark). pp 549-554 of Scientific basis for nuclear waste management. McCarthy, G.J. (ed.). New York, NY; Plenum Press (1979).

From Annual meeting of Materials Research Society; Boston, MA, USA (28 Nov 1978).

The following disposal concepts are compared: spent fuel or non-partitioned high-level waste (HLW) in geologic formation; partitioned HLW in geologic formation; non-partitioned HLW in submarine geologic formation; and partitioned, vitrified HLW, isolated by engineered containment, and emplaced on the deep ocean floor. Assuming that biofouling can be neglected, the last disposed concept is the most desirable.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 2435, 2639, 2676, 3607

2669 (ALO—0789-T14) Material properties of Eleana argillite: extrapolation to other argillaceous rocks, and implications for waste management. Lappin, A.R.; Olsson, W.A. (Sandia Labs., Albuquerque, NM (USA)). Oct 1979. Contract EY-76-C-04-0789. 15p. Dep. NTIS, PC A02/MF A01.

Results of a near-surface heater test in the Eleana argillite suggest the possibility that the high-temperature (> 100°C) thermomechanical response of argillite to waste emplacement may be dominated by behavior of expandable clays. Enough expandable clay is probably present in most argillaceous rocks to cause a similar response. In-situ thermal conductivities may be markedly reduced by even small amounts of clay contraction which results in opening of pre-existing joints. A simple model predicts that such behavior may continue to operate to considerable depths, though several factors affecting determination of this depth remain poorly defined at present.

2670 (DOE/EV—0046(Vol.2)) Proceedings of the US Department of Energy environmental control symposium. Volume 2. Nuclear energy and transportation. (Department of Energy, Washington, DC (USA). Div. of Environmental Control Technology; Argonne National Lab., IL (USA)). Sep 1979. Contract W-31-109-ENG-38. 617p. (CONF-781109—(Vol.2)). Dep. NTIS, PC A99/MF A01.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

Volume 2 contains papers from the following sessions: environmental control of fission/fusion power; nuclear waste disposal; decontamination and decommissioning; environmental control aspects of transportation; and hazardous materials transportation. Individual papers were processed.

2671 (PNL—2652) Waste Isolation Safety Assessment Program. A brief description of the three-dimensional finite element ground-water flow model adapted for waste isolation safety assessments. Cole, C.R.; Gupta, S.K. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Aug 1979. Contract EY-76-C-06-1830. 57p. Dep. NTIS, PC A04/MF A01.

Four levels of hydrologic models have been categorized to handle varying complexities and degrees of available input parameters. The first level is for the simplest one-dimensional models having analytical solutions; the second level includes idealized analytic or hybrid analytic models for single aquifer systems with scanty input data; the third level deals with more complex single or quasi-multilayered systems; and the fourth level is for complex multilayered systems. The three-dimensional finite element ground-water model described in this report falls under the fourth level of hydrologic models. This model is capable of simulating single-layered systems having variable thickness or multilayered systems where not only thickness can be varied, but the number of layers can be changed to agree with the vertical geologic section. Supporting programs have been developed to plot grid values, contour maps and three-dimensional graphics of the input data used in simulation as well as the results obtained. At present, the model considers only confined aquifers. The capabilities of the model were demonstrated by using a test case consisting of the multilayered ground-water system beneath Long Island, New York.

2672 (SAND—79-0900C) Brine chemistry effects on the durability of a simulated nuclear waste glass. Braithwaite, J.W. (Sandia Labs., Albuquerque, NM (USA)). 1979. Contract EY-76-C-04-0789. 8p. (CONF-791112—16). Dep. NTIS, PC A02/MF A01.

From Symposium on the scientific basis for nuclear waste management; Boston, MA, USA (26 Nov 1979).

The effects of various solution chemistry parameters on the alteration and leaching characteristics of a copper borosilicate simulated waste glass have been determined under hydrothermal conditions. Results are presented which demonstrate that leachant salinity, volume/glass surface area ratio, pH, cation content, and dissolved SiO_2 concentration effects are important. A brief explanation of these results is given which is based on ion exchange and solution saturation equilibria.

2673 (SAND—79-1016C) Radionuclide transport in a dolomite aquifer. Dosch, R.G.; Lynch, A.W. (Sandia Labs., Albuquerque, NM (USA)). 1979. Contract EY-76-C-04-0789. 8p. (CONF-791112—15). Dep. NTIS, PC A02/MF A01.

From Symposium on the scientific basis for nuclear waste management; Boston, MA, USA (26 Nov 1979).

The most probable paths for radionuclide transport between the biosphere and the proposed bedded salt repository (WIPP) in Southeastern New Mexico are through dolomite formations which are the only currently water-bearing units overlying the repository horizon. This paper describes some of the experimental work performed to determine the potential for radionuclide migration in these formations. Included are the results of radionuclide sorption studies on natural dolomites (Magenta and Culebra) and on synthetic dolomite (protodolomite). Sorption on natural dolomites was evaluated with respect to core sample location, groundwater composition, nuclide concentration, and water volume to rock mass ratios used in making the measurements. Results show that a discrete value such as a distribution coefficient (Kd) assigned to a given radionuclide does not accurately describe its interactions with site-specific geological formation.

2674 (UCRL—15102) Effects of brine migration on waste storage systems. Final report. Gaffney, E.S.; Nickell, R.E. (Pacifica Technology, Del Mar, CA (USA)). 15 May 1979. Contract W-7405-ENG-48. 31p. Dep. NTIS, PC A04/MF A01.

Processes which can lead to mobilization of brine adjacent to spent fuel or nuclear waste canisters and some of the thermomechanical consequences have been investigated. Velocities as high as 4×10^{-7} m s^{-1} (13 m y^{-1}) are calculated at the salt/canister boundary. As much as 40 liters of pure NaCl brine could accumulate around each canister during a 10-year storage period. Accumulations of bittern brines would probably be less, in the range of 2 to 5 liters. With 0.5% water, NaCl brine accumulation over a 10-year storage cycle around a spent fuel canister producing 0.6 kW of heat is expected to be less than 1 liter for centimeter-size inclusions and less than 0.5 liter for millimeter-size inclusions. For bittern brines, about 25 years would be required to accumulate 0.4 liter. The most serious mechanical consequence of brine migration would be the increased mobility of the waste canister due to pressure solution. In pressure solution enhanced deformation, the existence of a thin film of fluid either between grains or between media (such as between a canister and the salt) provides a pathway by which the salt can be redistributed leading to a marked increase in strain rates in wet rock relative to dry rock. In salt, intergranular water will probably form discontinuous layers rather than films so that they would dominate pressure solution. A mathematical model of pressure solution indicates that pressure solution will not lead to appreciable canister motions except possibly in fine grained rocks (less than 10^{-4} m). In fine grained salts, details of the contact surface between the canister and the salt bed may lead to large pressure solution motions. A numerical model indicates that heat transfer in the brine layer surrounding a spent fuel

canister is not conduction dominated but has a significant convective component.

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 2574, 2626, 2628, 2644, 2646, 2648, 2659, 2663, 2665, 2666, 3590

2675 (DOE/EV—0046(Vol.2), pp 149-158) **Decontamination and decommissioning plutonium-contaminated facilities at the Hanford site.** Graves, A.W. (Rockwell Hanford Operations, Richland, WA). Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

A D and D program is being performed by Rockwell Hanford Operations for the Department of Energy/Environmental Control Technology Division to: formulate long-range plans and schedules for D and D of surplus facilities at Rockwell Hanford; develop a broad-based planning system for application to all D and D projects; develop new technology to increase the safety and/or efficiency of D and D operations; evaluate D and D technology through field testing and analysis; prepare detailed work procedures and execute D and D operations on the basis of an identified long-range plan and schedule; and demonstrate the above objectives on a relatively small plutonium-separation process facility which is grossly contaminated. Current status of this program after a year of progress is presented, including the initial efforts in the 233-S Building at Hanford.

2676 (DOE/EV—0046(Vol.2), pp 159-182) **Environmental protection experience in AI's decommissioning programs.** Ureda, B.F.; Carroll, J.W. Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

In the past five years, the Atomics International Division has completed or has in work for the DOE the decommissioning of eight nuclear facilities ranging from a hot cave laboratory to the Sodium Reactor Experiment and a contaminated sanitary leach field. These are DOE-funded programs to remove all radioactive materials significantly in excess of background and to return the sites and facilities to unrestricted use. The radioactive materials involved are fission and activation products and occurred both as surface contaminants and integrated within structural materials. Contaminated soil was also identified and removed. The decommissioning activities were planned, engineered and performed so as to preclude detrimental impacts to the environment. During decommissioning, the operating areas were controlled to very low levels of surface contamination to prevent airborne contamination generation and prevent transfer from the site. Activities where the potential for contamination spread was great, required special controls and techniques to limit dispersal. The principal successful controls and techniques, as developed to meet the singular conditions of the decommissioning programs are: Na reaction exhaust gases condensing, venting, and hydrogen dilution; hot cell personnel air locks; thermal ring cutup enclosure and exhaust; reactor vessel cutup water shielding and water purification, surface decontamination with foam; concrete surface decontamination using scrubber, sandblasting, jack hammers in dust containments; bagging techniques for large components; dust control during excavation; and packaging and transportation controls for disposal by burial.

2677 (DOE/EV—0046(Vol.2), pp 183-207) **New decontamination techniques for exposure reduction.** Arrowsmith, H.W.; Allen, R.P. (Battelle Pacific Northwest Labs., Richland, WA). Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

Research is being conducted at PNL to develop effective techniques for removing plutonium and other radionuclide contamination from a variety of metal surfaces. The successful development and widespread application of effective decontamination techniques will substantially reduce the volume of metallic waste requiring expensive perpetual care or geologic disposal. Other benefits include minimization of personnel exposure, reduced risk of environmental contamination, and the preservation of large quantities of irreplaceable metals and alloying elements for possible future use. Electropolishing, vibratory finishing, and liquid blasting are among the commercial metal finishing techniques that are being studied for decontamination applications. Electropolishing is an electrochemical process used in both laboratory and industrial applications to produce a smooth, polished surface on a variety of metals and alloys. Examples of objects that have been decontaminated within minutes using electropolishing include hot cell manipulator assemblies, analytical instrument components, laboratory transfer containers, offsite shipping containers, fission product storage capsules, laboratory animal cages, and nuclear reactor process tube components. Vibratory finishing techniques have been used to remove paint, grease, corrosion layers, and gross contamination from metallic components in a single step with a minimum of operator attention and at a high production rate. A plastic or ceramic media containing abrasive particles is vibrated at a high frequency in the presence of a cleaning solution. Liquid blasting techniques are also being evaluated for the removal of paint, grease, corrosion layers, and gross contamination. This technique utilizes compressed air to propel a liquid stream containing abrasive particles against the surface to be decontaminated. The fast moving abrasive stream is able to remove even tenacious epoxy coatings.

2678 (DOE/EV—0046(Vol.2), pp 273-292) **Analysis of migration pathways for geologic radioactive waste repositories.** Shipler, D.B. (Battelle Memorial Inst., Columbus, OH); Raymond, J.R.; Gnirk, P.F. Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

The major tasks of the National Waste Terminal Storage safety assessment programs are to: (1) develop modeling systems and data for predicting potential natural and man-induced release mechanisms; (2) determine release rates of various waste forms; (3) develop modeling systems to predict the transport of radioactive materials from repositories to the biosphere and to evaluate the potential radiation dose to humans; and (4) determine the various parametric values of rocks and rock formations necessary to carry out the modeling activities. This paper reviews the ongoing program for analyzing the significance of various suggested pathways by which radioactivity might migrate from deep geologic repositories. The analyses consider both the probability of the suggested cause occurring, and the probable impact of the occurrence. The pathways include those involved in sudden natural phenomena, such as earthquakes and vulcanism; pathways provided by slowly-evolving natural phenomena, such as erosion; pathways provided by phenomena due to the waste itself, such as stresses from radioactive decay heat or subsidence induced by incomplete back-filling of the repository; and pathways provided by human instrusion, such as drilling for mineral resources. A detailed analysis is provided for a natural faulting event that disrupts a spent fuel repository in a reference bedded salt regime. The analysis starts with the post faulting conditions and covers the transport of the waste to an aquifer and on through the aquifer to surface discharge. The results are given in concentrations of the waste in the discharge. The exercise was conducted to demonstrate the development of the transport modeling system and its potential use in repository design and site selection and qualification.

2679 (DOE/EV—0046(Vol.2), pp 529-545) **Risk assessment of energy material transportation systems.** Rhoads, R.E.; Geffen, C A. (Battelle Pacific Northwest Labs., Richland, WA). Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

An assessment of the environmental impacts of energy systems should include an analysis of the transportation of required energy materials. Risk assessment techniques can help to define the potential environmental impacts and evaluate the safety of a transportation system. This paper presents the risk assessment methodology developed in Pacific Northwest Laboratory's Transportation Safety Studies Project, which was conducted for the Transportation Branch of DOE's Division of Environmental Control Technology and reviews the results of studies that have been completed to date. The risk methodology includes four basic components. A detailed system description is first obtained to provide projected industry characteristics, size and number of material shipments required, material characteristics, container types, transportation modes and routes, and weather and population zones. Fault tree analysis is then used to identify the sequences of events that could lead to a release of material from the transport vehicle. The probabilities of a particular release sequence occurring and the consequences of that release are evaluated next, using container failure data and mathematical models for dispersion and health effects. The environmental behavior characteristics and health effects of the material must be developed individually for each substance transported. Finally, the risks associated with each shipping route are calculated and summed to obtain total risk. The results of the risk assessment are analyzed to determine the primary contributors to the risk and to specify and evaluate alternatives that could reduce the system risk, if the current risk is judged by society to be unacceptable. Sensitivity studies are also carried out to test the effect on the system risk of assumptions and approximations that were made to develop key pieces of information. These studies may identify areas where further analysis is required.

2680 (HEDL-SA—1816) **Fissionable material handlers certification training program.** Strangeland, J.V. (Westinghouse Hanford Co., Richland, WA (USA)). Jul 1979. Contract EY-76-C-14-2170. 12p. (CONF-791203—3). Dep. NTIS, PC A02/MF A01.

From Health Physics Society meeting; Honolulu, HI, USA (10 Dec 1979).

A formal program for certification of fissionable material handlers is presented that cultivates safe working practices. This

certification complies with the training requirements of the Department of Energy Directive 0530 (ERDA Manual Chapter 0530), Nuclear Criticality Safety. The program consists of a series of classroom lectures, on-the-job training, and examinations in criticality safety, radiation protection, industrial safety, emergency procedures, and the employee's specific work operations. The program for recertification is also discussed.

2681 Nuclide transport by groundwater in Swedish bedrock. Allard, B.; Kipatsi, H.; Torstenfelt, B.; Rydberg, J. (Chalmers Univ. of Tech., Goeteborh, Sweden). pp 403-410 of Scientific basis for nuclear waste management. McCarthy, G.J. (ed.). New York, NY; Plenum Press (1979).

From Annual meeting of Materials Research Society; Boston, MA, USA (28 Nov 1978).

The sorption of 14 different elements (Cs, Sr, Ra, Zr, Tc, I, Nd, Ce, Eu, Th, U, Np, Pu and Am) has been measured on granite and on a bentonite/quartz mixture (10:90) under environmental conditions. Retention factors have been calculated. The investigation was performed within the Swedish Nuclear Fuel Safety Project.

2682 Analysis of Pu-release consequences on the environmental geochemistry. Jakubick, A.T. (Kernforschungszentrum, Karlsruhe, Germany). pp 427-434 of Scientific basis for nuclear waste management. McCarthy, G.J. (ed.). New York, NY; Plenum Press (1979).

From Annual meeting of Materials Research Society; Boston, MA, USA (28 Nov 1978).

The fallout plutonium depth distribution in soil was estimated at seven undisturbed sites. The mobility of plutonium in these natural soils was derived as 0.2 to 2 cm/y. By relating the flow velocity of soil water to the migration rate, the retardation factor was thereby obtained. The typical magnitude of plutonium transfer response to the partially saturated water flow is 10^{-3}. A linear relationship exists between the fallout plutonium retardation factor and three soil parameters: surface exchange capacity, porosity and pH. Also, in the course of the investigations the Pu-base-line was established for SW-Germany. Thus, any local deviation can be identified by using a log-probability plot with these background data. By means of the relationship derived, realistic predictions concerning persistence and dispersion of Pu-anomalies can be made for any site chosen.

2683 Preliminary safety assessment of the WIPP facility. Balestri, R.J. (BDM Corp., Albuquerque, NM); Torres, B.W.; Pahwa, S.B.; Brannen, J.P. pp 513-520 of Scientific basis for nuclear waste management. McCarthy, G.J. (ed.). New York, NY; Plenum Press (1979).

From Annual meeting of Materials Research Society; Boston, MA, USA (28 Nov 1978).

The efforts to perform a safety assessment of the WIPP facility being proposed for southeastern New Mexico are summarized. This preliminary safety assessment of the WIPP facility is limited to a consequence assessment in terms of the dose to a maximally exposed individual as a result of introducing the radionuclides into the biosphere. No attempt has been made to extend the consequences to population dose or to weight the dose with probability of the events. The general methodology, geosphere transport, and biosphere transport are described. The consequences of the various models developed to represent the loss of containment are summarized.

2684 Computer enhanced release scenario analysis for a nuclear waste repository. Stottlemyre, J.A.; Petrie, G.M.; Mullen, M.F. (Battelle Pacific Northwest Labs.). pp 521-531 of Scientific basis for nuclear waste management. McCarthy, G.J. (ed.). New York, NY; Plenum Press (1979).

From Annual meeting of Materials Research Society; Boston, MA, USA (28 Nov 1978).

An interactive (user-oriented) computer tool is being developed at PNL to assist in the analysis of release scenarios for long-term safety assessment of a continental geologic nuclear waste repository. Emphasis is on characterizing the various ways the geologic and hydrologic system surrounding a repository might vary over the 10^6 to 10^7 years subsequent to final closure of the cavern. The potential disruptive phenomena are categorized as natural geologic and man-caused and tend to be synergistic in nature. The computer tool is designed to permit simulation of the system response as a function of the ongoing disruptive phenomena and time. It is designed to be operated in a determinatic manner, i.e., user selection of the desired scenarios and associated rate, magnitude, and lag time data; or in a stochastic mode. The stochastic mode involves establishing distributions for individual phenomena occurrence probabilities, rates, magnitudes, and phase relationships. A Monte-Carlo technique is then employed to generate a multitude of disruptive event scenarios, scan for breaches of the repository isolation, and develop input to the release consequence analysis task. To date, only a simplified one-dimensional version of the code has been completed. Significant modification and development is required to expand its dimensionality and apply the tool to any specific site.

2685 Release of radionuclides from high-level waste during transportation fires. Ensminger, D.A. (Analytic Sciences Corp., Reading, MA); Sutherland, A.A.; Oston, S.G.; Van Konynenburg, R.A. pp 541-548 of Scientific basis for nuclear waste management. McCarthy, G.J. (ed.). New York, NY; Plenum Press (1979).

From Annual meeting of Materials Research Society; Boston, MA, USA (28 Nov 1978).

An analysis is performed to determine doses to humans that result from fire accidents in rail or truck transportation of solidified high-level nuclear waste. Four waste forms are analyzed: spray calcine, fluidized-bed calcine, borosilicate glass, and a special multi-barrier waste form. It is possible to establish discrete containment failure temperatures for each waste form. Using probabilistic models for fire accidents in truck and rail transportation modes, the expected value of population dose for each of the four waste forms is computed.

REGULATIONS

ACCOUNTABILITY AND SAFEGUARDS

2686 (ANL/EES-TM—67) Review of the nuclear safeguards problem. Poch, L.A.; Wolsko, T.D. (Argonne National Lab., IL (USA)). Oct 1979. 20p. Dep. NTIS, PC A02/MF A01.

The issues surrounding nuclear safeguards are proliferation and terrorism. Protecting the nuclear fuel cycle against nuclear materials diversion has been the function of the NPT and the IAEA. However, because all nations have not signed the NPT and IAEA safeguarding inspections are not foolproof, the fuel cycle itself has been looked to as a possible way to alleviate concerns over proliferation. A civilian nuclear industry is not needed to produce weapon material, since research reactors can provide the necessary weapon-grade uranium or plutonium much cheaper and easier than commercial power reactors. Thus, altering the nuclear fuel cycle does not necessarily reduce the possibility of proliferation of nuclear weapons. Only strict enforcement of the NPT and of the safeguard guidelines of the IAEA can achieve nonproliferation. Changing the fuel cycle does not present terrorists from stealing highly radioactive material to be used for weapons or from sabotaging nuclear facilities. Policing a nuclear facility by using guards, alarms, barriers, and searching and screening of employees is the only way to protect against terrorism, but these actions raise questions regarding civil liberties.

2687 (LA—7838-MS) Irradiated fuel monitoring by Cerenkov glow intensity measurements. Dowdy, E.J.; Nicholson, N.; Caldwell, J.T. (Los Alamos Scientific Lab., NM (USA)). Sep 1979. Contract W-7405-ENG-36. 14p. Dep. NTIS, PC A02/MF A01.

Attribute measurement techniques for confirmation of declared irradiated fuel inventories at nuclear installations under safeguards surveillance are being investigated. High-gain measurements of the intensity of the Cerenkov glow from exposed assemblies in water-filled storage ponds are promising for this purpose. Such measurements have been made of Materials Testing Reactor plate-type fuel assemblies and Pressurized Water Reactor pin-type fuel assemblies. The measured intensities depend on cooling times as calculations predict.

2688 (LA—8070-MS) Tokai advanced safeguards technology exercise task T-F: study of selected capabilities needed to apply DYMAC principles to safeguarding the Tokai reprocessing plant. Lowry, L.L.; Augustson, R.H. (comps.). (Los Alamos Scientific Lab., NM (USA)). Oct 1979. Contract W-7405-ENG-36. 56p. Dep. NTIS, PC A04/MF A01.

Selected technical capabilities needed to apply the DYMAC principles to safeguarding the Tokai reproprocessing plant are presented. The measurements needed to close the mass balance around the process line and the analysis methods for assessing the results were investigated. Process conditions at the Tokai plant were used when numerical values were needed to assist the analyis. A rationale is presented for the selection of instruments (x-ray fluorescence spectrometers, x-ray densitometers, and gamma-ray spectrometers) best suited to establishing plutonium concentrations and inventories in the feed tanks. The current state of the art in estimating inventory in contactors is reviewed and profitable directions for further work are recommended. A generalized performance surface has been developed that can measure the diversion sensitivity of the safeguard system when the instrument performance levels, the number of measurements made, and the false alarm probability are specified. An analysis of its application to the Tokai plant is given. Finally, a conceptual approach to the problem of IAEA safeguards verification is discussed. It appears possible that, in the process of verifying, the full power of the plant operator's safeguard system can be brought to the service of the IAEA.

2689 (NUREG/CR—0772) Auditing measurement control programs. Roberts, F.P.; Brouns, R.J. (Battelle Pacific Northwest Labs.,

Richland, WA (USA)). Oct 1979. Contract EY-76-C-06-1830. 22p. (PNL—3019). Dep. NTIS, PC A02/MF A01.

Requirements and a general procedure for auditing measurement control programs used in special nuclear material accounting are discussed. The areas of measurement control that need to be examined are discussed and a suggested checklist is included to assist in the preparation and performance of the audit.

2690 (NUREG/CR—0921) **Programmer's manual for TRNSM 2.** Woo, C.W.; Anderson, G.M. (ORINCON Corp., La Jolla, CA (USA)). Sep 1979. Contract EY-76-C-04-0789. 247p. (SAND—78-8198). Dep. NTIS, PC A11/MF A01.

A vital part of the system for safeguarding special nuclear material is the system used to transport this material. In order to analyze the effects of various factors on the size, composition and efficiency of the transportation system, a computerized model of the system is required. This model must include all the major features of this transportation network, including the shipment schedule, different transportation modes, requirements for security escort vehicles, different maintenance requirements for trucks and escort vehicles, personnel assignment policies, and provisions for convoying trucks and escort vehicles. The TRNSM 2 computer program has been developed to provide this capability. Based on a shipment schedule, maintenance rules, work rules, vehicle carrying capacities and the types of transport unit elements to be considered, TRNSM 2 provides the fleet sizes and the detailed itineraries of the transport unit elements required to handle the shipments in the shipment schedule. This programmer's manual provides details on the TRNSM 2 computer program.

2691 (NUREG/CR—0950) **Review of the application of strategic analysis to material accounting.** Bennett, C.A.; Goldman, A.J.; Higinbotham, W.A.; Jaech, J.L.; Lucas, W.F.; Lumb, R.F. (Argonne National Lab., IL (USA)). Aug 1979. Contract W-31-109-ENG-38. 58p. Dep. NTIS, PC A04/MF A01.

The Peer Review Group feels that game theory may provide a useful basis for formulating safeguards problems and for arriving at decisions. Game theory should be considered as a complement to other methods for acting on nuclear material inventory differences, but it is not mature yet to be used in the NRC decision-making process. Recommendations are given. (DLC)

2692 (ORNL/CSD—37) **MUICYCL and MUIFAP: models tracking minor uranium isotopes in the nuclear fuel cycle.** Blum, S.R.; McLaren, R.A. (Oak Ridge National Lab., TN (USA)). Oct 1979. Contract W-7405-ENG-26. 118p. Dep. NTIS, PC A06/MF A01.

Two computer programs have been written to provide information on the buildup of minor uranium isotopes in the nuclear fuel cycle. The Minor Uranium Isotope Cycle Program, MUICYCL, tracks fuel through a multiyear campaign cycle of enrichment, reactor burnup, reprocessing, enrichment, etc. MUICYCL facilities include preproduction stockpiles, U^{235} escalation, and calculation of losses. The Minor Uranium Isotope Flowsheet Analyzer Program, MUIFAP, analyzes one minor isotope in one year of an enrichment operation. The formulation of the enrichment cascade, reactors, and reprocessing facility is presented. Input and output descriptions and sample cases are presented. The programs themselves are documented by short descriptions of each routine, flowcharts, definitions of common blocks and variables, and internal documentation. The programs are written in FORTRAN for use in batch mode.

2693 (PNL—2558) **Estimation of inspection effort.** Mullen, M.F.; Wincek, M.A. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Jun 1979. Contract EY-76-C-06-1830. 80p. (ISPO—35). Dep. NTIS, PC A05/MF A01.

An overview of IAEA inspection activities is presented, and the problem of evaluating the effectiveness of an inspection is discussed. Two models are described - an effort model and an effectiveness model. The effort model breaks the IAEA's inspection effort into components; the amount of effort required for each component is estimated; and the total effort is determined by summing the effort for each component. The effectiveness model quantifies the effectiveness of inspections in terms of probabilities of detection and quantities of material to be detected, if diverted over a specific period. The method is applied to a 200 metric ton per year low-enriched uranium fuel fabrication facility. A description of the model plant is presented, a safeguards approach is outlined, and sampling plans are calculated. The required inspection effort is estimated and the results are compared to IAEA estimates. Some other applications of the method are discussed briefly. Examples are presented which demonstrate how the method might be useful in formulating guidelines for inspection planning and in establishing technical criteria for safeguards implementation.

2694 (SAND—79-1534) **Optimal improvement of networks to nuclear safeguards problems: an alternate view.** Slater, P.J. (Sandia Labs., Albuquerque, NM (USA)). Aug 1979. Contract EY-76-C-04-0789. 15p. Dep. NTIS, PC A02/MF A01.

Networks have been used to model fixed-site security systems and to determine optimal travel routes of thieves or saboteurs. Considered here is the problem of upgrading the security by optimally investing in means to increase the travel time and/or detection probabilities over the arcs of the network. It is shown how to formulate a single linear programming problem to answer the following question. If the cost of increasing travel time is linear for each arc, what is the minimum amount of money one must invest to guarantee that there does not exist a path for thief or saboteur of length less than a fixed time T?

ADMINISTRATIVE AND REGULATORY

2695 **Fuel assurance and supply security.** Warnecke, S.J. (International Inst. for Strategic Studies, London (UK)). pp 313-324 of Uranium supply and demand. Spriggs, M.J.; Casteel, K.D. (eds.). London; Mining Journal Books (1978).

From 3. international symposium on uranium supply and demand; London, UK (12 Jul 1978).

Differences between uncertainties relating to uranium and to petroleum supplies are analyzed. Uranium is linked simultaneously to energy and to non-proliferation policies. The differences between the countries from which supplies are obtained are also discussed. Efforts of various international organizations to secure assured supplies are considered. The discussions at INFCE (International Nuclear Fuel Cycle Evaluation) are referred to. The part played by USA is outlined: U.S. fuel assurance proposals; analysis of the U.S. proposal. The relationship between petroleum and uranium supplies is examined, and new trends in the petroleum and uranium industries are discussed.

FUSION FUELS

SOURCES

REFER ALSO TO CITATION(S) 3474

PROCESSING

FABRICATION AND TESTING

2696 (UCRL—83000) **Plasma processed coating of laser fusion targets.** Johnson, W.L.; Letts, S.A.; Myers, D.W.; Crane, J.K.; Illige, J.D.; Hatcher, C.W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 19 Sep 1979. Contract W-7405-ENG-48. 4p. Dep. NTIS, PC A02/MF A01.

Coatings for laser fusion targets have been deposited in an inductively coupled discharge device by plasma polymerization. Two feed gases were used: perfluoro-2-butene, which produced a fluorocarbon coating ($CF_{1.3}$) with a density of 1.8 g/cc, and trans-2-butene which produced a hydrocarbon coating ($CH_{1.3}$) with a density of 1.0 g/cc. Uniform pin-hole free films have been deposited to a thickness of up to 30 μm of fluorocarbon and up to 110 μm of hydrocarbon. The effect of process variables on surface smoothness has been investigated. The basic defect in the coating has been found to result from shadowing by a small surface irregularity in an anisotropic coating flux.

ISOTOPE AND RADIATION SOURCE TECHNOLOGY

PHYSICAL ISOTOPE SEPARATION

REFER ALSO TO CITATION(S) 3785

2697 **Nitrogen isotope separation by multiphoton dissociation of methylamine.** Chen, H.; Borzileri, C. (University of California, Lawrence Livermore Laboratory, P.O. Box 808, L-468, Livermore, California 94550). *J. Appl. Phys.;* **50**: No. 11, 7177-7180(Nov 1979).

A selective multiphoton photochemical process has been used to enrich nitrogen-14 isotope in methylamine. A separation factor of 2 has been achieved for irradiation of $CH_3N^{14}H_2/CH_3N^{15}H_2/NO$ sample with the P (24) line of the 9.6-μ CO_2 laser transition. The threshold laser energy fluence for reaction is roughly 30 J/cm^2. The vibrational isotope shift of methylamine at the 9.6-μ region was found to be 12.5 cm^{-1}. The selectivity of the photochemical reaction appears to be limited by the overlap of vibrational-rotational lines of

$CH_3N^{14}H_2$ and $CH_3N^{15}H_2$ molecules due to power broadening under the intense laser field.

RADIATION SOURCES

2698 (GEPP-OP—463) **Thermal desorption analysis applied to materials characterization.** Mehrhoff, T.K. (General Electric Co., St. Petersburg, FL (USA). Neutron Devices Dept.). 1979. Contract EY-76-C-04-0656. 15p. (CONF-791068—1). Dep. NTIS, PC A02/MF A01.

From General Electric materials characterization symposium; Schenectady, NY, USA (24 Oct 1979).

Thermal desorption analysis is used to characterize the outgassing properties of both vacuum envelope materials and the hydrided sources and targets in neutron generators employing erbium deuteride films and erbium tritide target.

OTHER INDUSTRIAL USES

2699 **Solids irradiator.** Morris, M.E.; Pierce, J.D.; Whitfield, W.J. (to Dept. of Energy). US Patent 4,151,419. 24 Apr 1979. Filed date 20 Oct 1977. 10p.

The invention discloses a novel facility for irradiation of solids embodying pathogens wherein solids are conveyed through an irradiation chamber in individual containers of an endless conveyor.

ISOTOPIC POWER SUPPLIES

DESIGN AND FABRICATION

2700 (LA—7972-MS) **LASL fabrication flowsheet for GPHS fuel pellets.** Kent, R.A. (Los Alamos Scientific Lab., NM (USA)). Aug 1979. Contract W-7405-ENG-36. 45p. Dep. NTIS, PC A03/MF A01.

The General Purpose Heat Source (GPHS) being developed by the Los Alamos Scienific Laboratory for the Department of Energy, Division of Advanced Nuclear Systems and Projects, consists of a series of graphite modules, each having a thermal power inventory of 62.5 watts. Each module is loaded with four cylindrical 62.5-W $^{238}PuO_2$ fuel pellets. The report summarizes the specifications for these pellets together with the fabrication flowsheet developed at LASL.

HYDROGEN

REFER ALSO TO CITATION(S) 3359

PRODUCTION

2701 (BLG—526) **Hydrogen as an energy vector.** Vandenborre, H.; Baetsle, L.H. (Centre d'Etude de l'Energie Nucleaire, Brussels (Belgium); Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). Apr 1979. 30p. Dep. NTIS (US Sales Only), PC A03/MF A01.

Some aspects of hydrogen as an energy vector complementary to electricity are outlined. Two production methods for hydrogen are described which do not make use of fossil fuels, e.g. the electrochemical and thermochemical split up of water. Afterwards, the storage of hydrogen has been discussed as a gas, a liquid or a metal hydride. Each of these storage possibilities is illustrated with a realization for great and small amounts of hydrogen. Transport, distribution and security of hydrogen are outlined and finally some brief aspects of the hydrogen production economy have been given.

2702 (TAC/H—79-002) **Hydrogen energy: a bibliography with abstracts. Quarterly update, April-June 1979.** (New Mexico Univ., Albuquerque (USA). Technology Application Center). Jun 1979. 102p. Univ. of New Mexico, Albuquerque, NM 87131.

Material on the subject of hydrogen as a secondary fuel and as an energy carrier is cited. Hydrogen production, utilization, transmission, distribution, storage, safety, and materials are covered.

2703 **High yield solid propellant hydrogen generators.** Flanagan, J.E. (to Rockwell International Corp.). US Patent 4,166,843. 4 Sep 1979. Filed date 27 Feb 1978. 2p.

A solid propellant gas generator system uses borane compounds of the formula (CH_3)/sub x/H/sub 4-x/NB_3H_8 as the primary hydrogen source and a metallic complexing agent to trap the carbon molecules as solid metallic carbides.

ELECTROLYSIS

REFER ALSO TO CITATION(S) 2706

2704 (EPRI-EM—1154) **Market potential for electrolytic hydrogen. Final report.** Fein, E.; Mathey, C.J.; Arnstein, C. (Futures Group, Glastonbury, CT (USA)). Aug 1979. 181p. Dep. NTIS, PC A09/MF A01.

The economics of hydrogen production by the major users of hydrogen (petroleum refiners and manufacturers of ammonia and methanol) favor the continued use of fossil fuels for hydrogen generation. However, there are a large number of miscellaneous small users for whom hydrogen produced by advanced electrolyzers may become economically attractive. Many of these small users, with hydrogen demands of $<$ 0.5 million SCF per day, purchase their hydrogen requirements from industrial gas suppliers. Forseeable improvements in current electrolyzer technology, which will reduce plant capital costs and improve plant performance and efficiency, may make electrolytic hydrogen competitive with purchased hydrogen for many specialty users. This study analyzed the small user hydrogen market. Telephone interviews were conducted with representative hydrogen users in the chemical, pharmaceutical, electronics, metals, fats and oils, and float glass industries to determine the decision factors governing the choice of their hydrogen supply. Cost projections to the year 2000 for production of hydrogen by advanced electrolyzers were made and compared with price projections for merchant hydrogen, and the estimates of the potential market for each of the industrial sub-sectors were determined. By the year 2000, the potential market for advanced technology electrolytic hydrogen among specialty users is projected to be about half of what the merchant hydrogen market would be in the absence of electrolytic hydrogen. This potential market, representing an annual demand of about 16 billion SCF of hydrogen, will develop from market penetrations of electrolyzers assumed to begin in the early 1980s.

THERMOCHEMICAL PROCESSES

2705 (JPL-PUB—79-46) **Methods for calculation of engineering parameters for gas separation.** Lawson, D.D. (Jet Propulsion Lab., Pasadena, CA (USA)). 1 Oct 1979. Contract ET-78-I-01-3112. 26p. Dep. NTIS, PC A03/MF A01.

A group additivity method has been generated which makes it possible to estimate, from the structural formulas alone, the energy of vaporization and the molar volume at 25°C of many nonpolar organic liquids. From these two parameters and appropriate thermodynamic relations it is then possible to predict the vapor pressure of the liquid phase and the solubility of various gases in nonpolar organic liquids. It is also possible to use the data to evaluate organic and some inorganic liquids for use in gas separation stages or liquids as heat exchange fluids in prospective thermochemical cycles for hydrogen production.

STEAM REFORMER PROCESSES

REFER ALSO TO CITATION(S) 2706

BIOSYNTHESIS AND PHOTOCHEMICAL PROCESSES

REFER ALSO TO CITATION(S) 3431

COAL GASIFICATION

REFER ALSO TO CITATION(S) 2706

STEAM-IRON PROCESS

2706 **Hydrogen from fossil fuels.** Gregory, D.P.; Tarman, P.B. Chicago, IL; Institute of Gas Technology (1979). 30p. (CONF-790942—2). The Publisher, 3424 S. State St., Chicago, IL 60616.

From Hydrogen in air transportation conference; Stuttgart, F.R. Germany (10 Sep 1979).

Hydrogen is manufactured today on an industrial scale by steam reforming of natural gas, partial oxidation of heavy oil, and coal gasification. As hydrogen becomes less available and more expensive worldwide, a reassessment of processes becomes necessary to evaluate new approaches to hydrogen production. This paper contains brief descriptions of existing, as well as new, processes for the production of hydrogen from gas, oil, and coal and by electrolysis. Some emphasis is given to the Steam-Iron Process because it repesents a novel method of producing pure hydrogen, which might be well adapted to liquid hydrogen production for aircraft fuel use. Estimates of hydrogen costs for each process are compared on a common economic basis, and the effects of changes in the major cost factors, such as feedback costs and by-product credits, are evaluated. The principal by-products are sulfur, oxygen in the case of electrolysis, and electric power in the case of the Steam-Iron Process. In

some situations, a combined steam-iron/electrolysis process appears attractive.

PARTIAL OXIDATION PROCESSES

REFER ALSO TO CITATION(S) 2706

STORAGE

REFER ALSO TO CITATION(S) 2701, 2702

TRANSPORT

REFER ALSO TO CITATION(S) 2701, 2702

MARKETING AND ECONOMICS

REFER ALSO TO CITATION(S) 2704

SAFETY

REFER ALSO TO CITATION(S) 2702, 2707

INDUSTRIAL AND COMMERCIAL USE

REFER ALSO TO CITATION(S) 2702, 3308

PROPERTIES

REFER ALSO TO CITATION(S) 3354, 3355, 3475

ENVIRONMENTAL ASPECTS

2707 (DOE/EV—0046(Vol.2), pp 515-528) **Critical review and assessment of environmetal and safety problems in hydrogen energy systems.** Edeskuty, F.J.; Bartlit, J.R.; Carlson, R.V. (Los Alamos Scientific Lab., NM). Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

Numerous suggestions have been made for the use of hydrogen in energy systems. Because these suggestions imply a concomitant increase in the quantity of hydrogen that must be produced, shipped, stored, and used, the possible safety and environmental impacts of these suggestions must be carefully assessed. From our studies on the safety aspects of hydrogen energy systems, we have concluded that the problem of hydrogen embrittlement can be solved through further research. Existing regulations and standards are adequate to encompass hydrogen development close to present usage levels. Large increases in quantity or degree of public exposure may require reconsideration of existing standards. It appears that hydrogen gas can be safely transmitted by pipeline. Whether existing natural gas pipelines can be used for hydrogen transmission has not yet been established; however, the addition of hydrogen to natural gas in quantities up to about 15% would seem to present no problems. Hydrogen is commonly shipped as a cryogenic liquid over long distances in unattended rail tank cars or in over-the-road tractor-trailer units. No safety problems have been observed, and this method of shipment could be considerably expanded with existing technology. Initial investigation indicates that both the production of the necessary primary energy and its use in the production of hydrogen may be detrimental to the environment; however, the generally positive impact of the end-use of hydrogen will ameliorate the negative effect of the production process.

OTHER SYNTHETIC AND NATURAL FUELS

PROPERTIES

REFER ALSO TO CITATION(S) 2462

2708 **Vapor pressures of high-molecular-weight hydrocarbons.** Macknick, A.B.; Prausnitz, J.M. (Univ. of California, Berkeley). *J. Chem. Eng. Data;* **24**: No. 3, 175-178(Jul 1979).

A gas-saturation apparatus is used to obtain experimental data at near-ambient temperature; vapor pressures in the range 10^{-1} to 10^{-3} torr are presented for the liquids n-octadecane, n-eiosane, 1-methylnaphthalene, and 2-ethylnaphthalene and the solids naphthalene, anthracene, and phenanthrene. Methods are recommended for extrapolating the data to higher temperature. These vapor-pressure data are useful for dewpoint calculations in processing of gases containing heavy hydrocarbons such as those found in coal tars. 4 figures, 2 tables.

2709 **Analytical study of the shock tube ignition of mixtures of methane and ethane.** Westbrook, C.K. (Univ of Calif, Lawrence Livermore Lab). *Combust. Sci. Technol.;* **20**: No. 1-2, 5-17(1979).

An analytical study of the ignition of mixtures of methane and ethane was carried out, using a numerical model consisting of 25 chemical species and 75 elementary chemical reactions. Computed ignition delay times and effective activation energies are compared with published experimental shock tube results. The chemical kinetic factors involved in the ignition of fuel mixtures are discussed in detail. The implications of these results for safety studies of liquefied natural gas are also examined.

PREPARATION

2710 **Synthetic fuels research and development.** Lee, B.S. Chicago, IL; Institute of Gas Technology (1979). 24p. (In Chinese and English). (NP—24087). The Publisher, 3424 S. State Street, Chicago, IL 60616.

The first part of this briefing reviews the significant factors and trends in energy production and consumption in the United States, as well as the major energy resources. In the United States, conventional production of oil and gas is expected to decrease with time, so that it becomes necessary to develop synthetic fuels from major fossil resources such as coal and oil shale. For the long term, renewable or inexhaustible energy source such as biomass and hydrogen can be gradually brought into the picture. Although a great deal of development work is in progress in the US in substitute natural gas (SNG) with calorific value of over 900 Btu per SCF, and in coal liquefaction to produce a synthetic crude, it appears that these technologies would not be of immediate interest to China. It would appear that clean fuels from coal through the production of medium-Btu gas for concentrated load centers should be of immediate interest. Furthermore, since China already has an oil shale industry, advanced technologies for enhancing recovery of hydrocarbons from shale, particularly from low grade shale, should be of interest. This paper discusses the U-Gas, HYTORT, and HYGAS processes in particular.

CHEMICAL SYNTHESIS

2711 **Polymer-supported eta^5-cyclopentadienylcobalt. An immobilized homogeneous Fischer-Tropsch catalyst.** Perkins, P.; Vollhardt, K.P.C. (Univ. of California, Berkeley). Contract W-7405-ENG-48. *J. Am. Chem. Soc.;* **101**: No. 14, 3985-3987(4 Jul 1979).

Polystyrene-supported eta^5-cyclopentadienylcobalt is catalytically active in the hydrogenation of carbon monoxide to give hydrocarbons. This activity must be due to a defined attached homogeneous cobalt species and not to deposited metal crystallites, and in contrast, soluble $CpCo(CO)_2$ is inactive and decomposed under hydrogenating conditions. The observed data characterize the title compound as the first catalyst activated to new activity on polymer attachment and the first immobilized homogeneous Fischer-Tropsch catalyst. 1 figure.

2712 **Conversion of synthesis gas to hydrocarbon mixtures.** Haag, W.O.; Huang, T.J. (to Mobil Oil Corp.). US Patent 4,157,338. 5 Jun 1979. Filed date 6 Mar 1978. 20p.

A mixture of carbon monoxide and hydrogen is contacted with a mixture comprising an element selected from the group consisting of ruthenium, rhodium and osmium carbon monoxide reduction catalyst and a crystalline alumino-silicate providing a pore dimension greater than about 5 Angstroms and a constraint index in the range of 1 to 12 to produce hydrocarbon mixtures useful in forming gasoline boiling range products, aromatic rich hydrocarbons, and chemical intermediates. 5 claims.

PREPARATION FROM WASTES OR BIOMASS

2713 **Method of testing a landfill for its methane potential.** Ham, R.K. (to Reserve Synthetic Fuels, Inc.). US Patent 4,159,893. 3 Jul 1979. Filed date 5 Dec 1977. 12p.

Method of testing a landfill for its methane potential comprising selecting a landfill which contains a significant decomposable fraction and a significant nondecomposable fraction, locating a plu-

rality of zones within the landfill with each of said zones having at least one different characteristic, taking at least one sample of the material of the landfill at each of the zones, measuring the content of each of the fractions of each of the samples, and utilizing the ratio of one of the fraction contents to the other of the fraction contents for at least some of the samples to find the approximate methane potential of the landfill.

ALCOHOL FUELS

REFER ALSO TO CITATION(S) 3285

PROPERTIES

REFER ALSO TO CITATION(S) 3521

PREPARATION FROM WASTES OR BIOMASS

REFER ALSO TO CITATION(S) 2786

SOLID WASTE FUELS

REFER ALSO TO CITATION(S) 2457, 3201, 3202

2714 (LA—7924-MS) **Wood burning for power production.** Leonard, E.M. (comp.). (Los Alamos Scientific Lab., NM (USA)). Aug 1979. Contract W-7405-ENG-48. 142p. Dep. NTIS, PC A07/MF A01.

The wood-fired boiler at the Vermont State Hospital in Waterbury, Vermont was investigated in order to identify environmental and economic problems associated with increased use of wood as fuel. The investigators observed that the low amount of stack emissions contained particulates that were extremely effective light scatterers. An analysis of the entire system was performed in order to investigate the particulate growth and the conversion of gaseous material to particulates within the system. Initial findings indicate that a good deal of particulate formation takes place within and after the cyclone, thus rendering the cyclone somewhat ineffective in this system. Meteorological data was acquired in the vicinity of the experimental site. Background concentrations were measured using hi-vol samplers and a Tracer experiment was performed to indicate the direction of plume travel. These data were incorporated into the Los Alamos Visibility Model to simulate the actual appearance of the plume with a variety of boiler sizes. This simulation gives one an indication of how large a boiler, sited in this location, can be before the opacity of the plume becomes aesthetically offensive. An economic assessment of the wood burning activities at Waterbury and a number of other sites is included in this report.

RESOURCES AND AVAILABILITY

REFER ALSO TO CITATION(S) 3609

SOLAR ENERGY

REFER ALSO TO CITATION(S) 2897

RESOURCES AND AVAILABILITY

REFER ALSO TO CITATION(S) 3585

2715 (SAND—78-1927, pp 22-24) **Correlations for diffuse solar radiation.** Collares-Pereira, M. (Univ. of Chicago, IL); Rabl, A. 1978.

From Analysis for solar heating and cooling; San Diego, CA, USA (27 Jun 1978).

For most locations the only available insolation measurements have been obtained with a horizontal pyranometer. But to predict the long term average performance of any collector (other than a horizontal flat plate) one needs to know both direct and diffuse insolation. Correlations of the type first derived by Liu and Jordan supply that information, but questions have been raised as to the validity of these correlations. Until now all studies of the Liu and Jordan correlations have been based on measurements of diffuse radiation by means of a pyranometer with shade ring. Since the shade ring blocks not only the solar disk but also a sizeable portion of the diffuse radiation, appropriate corrections must be applied. This problem is avoided if the solar beam radiation is measured with a pyrheliometer. Recently pyrheliometer data have become available from the Aerospace Corporation for Albuquerque, New Mexico; Fort Hood, Texas; Livermore, California; Raleigh, North Carolina; and Maynard, Massachusetts, with approximately two years at each station. We have analysed these data to check the Liu and Jordan correlations.

2716 (SAND—78-1927, pp 62-64) **Regional variation in solar radiation availability.** Bahm, R.J. (Univ. of New Mexico, Albuquerque). 1978.

From Analysis for solar heating and cooling; San Diego, CA, USA (27 Jun 1978).

Traditional methods of designing solar space heating systems often take one basic design and attempt to apply that single design in all areas and not in others. These conclusions are reached by examining the nature of the correlations between solar radiation and temperature, and by characterizing them in a manner which illustrates these regional differences. Much additional work needs to be done characterizing the solar radiation and load factor characteristics on a regional or local basis before standard or optimal designs can be established.

2717 (SAND—78-1927, pp 68-70) **Versatile, economical, solar irradiance computer model.** Hulstrom, R.L. (Solar Energy Research Inst., Golden, CO); Stadjuhar, S.A.; Schlaghbeck, R.A. 1978.

From Analysis for solar heating and cooling; San Diego, CA, USA (27 Jun 1978).

2718 (SAND—78-1927, pp 71-73) **Evaluation of methods of calculating solar radiation on an inclined surface.** Carter, E.A.; Patel, A.M. 1978.

From Analysis for solar heating and cooling; San Diego, CA, USA (27 Jun 1978).

Twenty-four different methods for computing solar radiation on inclined surfaces have been identified. While there are basic differences, such as some methods that use instantaneous, or hourly values which require a value for the solar angle and other methods that estimate total daily solar radiation, there are many procedures which are similar or identical. The various methods have been grouped according to their procedures and results, and primary methods have been evaluated with tilted measurements.

2719 **Solar simulation with tungsten-halogen quartz lamps and optical filters.** McMillan, J.A.; Peterson, E.M. (Argonne Natl Lab, Ill). Contract W-31-109-ENG-38. *Sol. Energy;* **22**: No. 5, 467-469(1979).

The paper reports a tungsten lamp solar simulator whose spectral distribution is significantly better than other incandescent lamp simulators. This simulator has been used for about a year in calorimetric determinations of absorptance of various materials, with periodic replacement of the lamp--after about 70 per cent of its lifetime--and position adjustment to reproduce the insolation of the sample. Equations are given for the solar simulator evaluation.

2720 **Summary of workshop discussions.** pp 3-42 of Climate and solar energy conversion. Williams, J.; Kroemer, G.; Weingart, J. (eds.). Laxenburg, Austria; International Institute for Applied Systems Analysis (1977).

From Acoustic emission meeting; London, UK (20 Dec 1976).

The following are summarized, the IIASA Climate Project, Climate and Mankind, weather and climate models, solar energy conversion as a global energy option, solar energy systems technologies, and comments, conclusions, and recommendations. (MHR)

ECONOMICS

REFER ALSO TO CITATION(S) 2800

2721 (SAND—78-1927, pp 88-90) **Economic optimization of solar energy and energy conservation in commercial buildings.** Sav, G.T. (National Bureau of Standards, Washington, DC). 1978.

From Analysis for solar heating and cooling; San Diego, CA, USA (27 Jun 1978).

The purpose of this paper is to provide an analytical framework for evaluating economic and technical performance trade-offs between solar energy and energy conservation options in buildings. The extended abstract outlines a methodology for determining the economically optimal combinations of solar energy system size and energy conservation investments to undertake in building design. The analysis is developed for combined space heating and hot water applications of solar energy in commercial buildings.

2722 (SAND—78-1927, pp 109-110) **Economic analysis for solar energy simulation.** Duram, R.E.; Reid, R.L.; Sullivan, W.G. 1978.

From Analysis for solar heating and cooling; San Diego, CA, USA (27 Jun 1978).

An economic analysis subroutine is described whose purpose is to produce financial data based on performance data from simulated solar energy systems. The subroutine accepts user-stated parametric inputs and simulated performance data. Some of the options available to the user before run-time are: residential vs commercial applications, new vs retrofit construction, equity vs debt financing, several tax incentive and depreciation plans, and four forms of energy. Each physical item (collector, pumps, valves, etc.) and most parameters such as interest rates, loan term, etc., have internally defaulted values. The subroutine performs break-even analysis based on the present-value method and life-cycle cash flow analysis, produces mortgage information (when applicable), benefit-to-cost ratio, costs fully allocated to the collector and determines an interest rate at which total solar savings exceeds total solar costs.

2723 (SAND—78-1927, pp 130-133) **Microeconomic approach to passive solar design: performance, cost, comfort, and optimal sizing.** Noll, S. (Los Alamos Scientific Lab., NM). 1978.

From Analysis for solar heating and cooling; San Diego, CA, USA (27 Jun 1978).

Results from the hour-by-hour PASOLE simulation algorithm developed by Los Alamos Scientific Laboratory's (LASL's) Q-11 Solar Group are used to determine composite performance equations which express the annual delivered solar heating fraction as a function of the specified input parameters. To insure compatibility, the input specifications are consistent with architectural design schematics and incremental cost factors attributable to the solar portion of a new single family tract home residence. Performance and incremental solar costs can then be combined to arrive at optimal expansion paths which indicate the least cost method or design of providing a given solar fraction. When constraints imposed by material availability, building code requirements, or comfort preferences are considered, the expansion paths are altered so that sizing and design becomes a constrained optimization procedure. Economic performance is then measured by several financial indicators including years to mortgage payback, years to positive savings, net present value, and equivalent annual costs.

2724 (SERI/TR—53-100) **Review of regional economic models with special reference to labor impact assessment.** Ferris, G.; Mason, B. (Solar Energy Research Inst., Golden, CO (USA)). Jun 1979. Contract EG-77-C-01-4042. 48p. Dep. NTIS, PC A03/MF A01.

This paper reviews several regional economic models and examines the capabilities of these models for assessing the total employment impacts of solar energy adoption. Five generic analytic methods are discussed: economic base analysis, shift-share analysis, demographic-economic interaction models, input-output analysis, and industrial location analysis. Ten regional models incorporating some aspect of these methods are reviewed. From the model review, the conclusion is drawn that there is no single model that fits all of the necessary criteria for planned research efforts. Models that appear to hold promise are the Economic Activity Analysis (EAA) Model, the Regional Industrial Multipliers System (RIMS), the Multiregion, Multi-industry (MRMI) Model, and the MULTIREGION model.

2725 **California's Solar Energy Tax Credit: an analysis of tax returns for 1977.** Rains, D.W. Sacramento, CA; California Energy Commission (Sep 1979). 54p. (NP—24094).

In 1977, the California Legislature established a 55% state income tax credit to encourage the use of solar energy systems in homes and businesses. Since enactment of the California Solar Tax Credit, over 40,000 taxpayer households have installed a solar energy system for water heating (pool and domestic), space conditioning (active and passive) or combined solar energy systems. Using statistical tabulations provided by the Franchise Tax Board, the California Energy Commission has analyzed the results of the first year of the credit. These results are presented in terms of the number, type, total cost and geographical distribution of the credits. In addition, a breakdown by type of solar energy system installed and the distribution of credits across income groups are also tabulated. These tabulations provide an excellent mechanism for accurately tracking solar energy use in California and allows government and industry to accurately monitor trends and shifts in market acceptance of the various solar energy technologies.

ENVIRONMENTAL, LEGAL, AND INSTITUTIONAL ASPECTS

REFER ALSO TO CITATION(S) 2724, 2725, 2845, 3586

2726 (DOE/EV—0046(Vol.3), pp 73-83) **Overview of photovoltaic environmental issues.** Lawrence, K.A. (Solar Energy Research Inst., Golden, CA). Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

The environmental issues associated with each phase of the life cycle - resource extraction and processing, cell manufacture, system installation and operation, and system decommission - are summarized. The primary focus is on the semiconductor materials themselves and on centralized energy facilities rather than distributed systems; energy storage systems are not addressed. Photovoltaic systems are materials intensive compared to fossil fuel electric plants with the same power rating. As a result, extraction and processing of resource inputs for cell production (silicon for silicon cells; cadmium, sulfur and copper for cadmium sulfide cells [CdS]; gallium and arsenic for gallium arsenic cells [GaAs]) will release significant quantities of particulates as well as other toxic air emissions, miscellaneous water pollutants, and solid wastes. The greatest potential for adverse environmental effects occurs during cell manufacture. Production of all three cell types will emit significant quantities of particulates. Cadmium sulfide cell production could release as much as 34 T cadmium, 52 T cadmium sulfide, and unspecified quantities of cadmium oxide fumes per 10 MW/sub e/ cells. System operation is relatively benign. None of the cell types emit air or water pollutants under normal operating conditions. However, toxic fumes could be released, particularly from CdS or GaAs systems, in the case of fire. Facility decommission should present no serious environmental hazards for silicon cell systems. However, disposal or recycle of spent CdS and GaAs cells will require care and further research attention.

2727 (DOE/EV—0046(Vol.3), pp 85-92) **Environmental control technology in the solar photovoltaic industry: now and in the future.** Hild, N.R.; Coleman, M.G. (Motorola, Inc., Phoenix, AZ). Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

Manufacturing of solar cells is performed with process steps commonly utilized in the semiconductor industry. Present process sequences incorporate a broad spectrum of wet chemistry steps for etching and cleaning and utilize large quantities of hazardous gases in high temperature diffusion steps. Present technology is highly materials intensive; most of these materials do not appear in the final product. Control and disposal of waste materials is a major environmental and cost factor in today's manufacturing. Since the cost of a product is ultimately limited by the cost of consumed materials, both for utilization and for disposal, an economic driving force exists to reduce materials consumption. Manufacturing sequences of the future will be simpler and consume fewer materials than sequences now utilized. Savings will be realized through replacement of some wet chemistry steps with dry processes. Ion implantation will replace gaseous diffusion. Emphasis will be to minimize consumed materials and to recycle by-products. Example manufacturing sequences are presented.

2728 (DOE/EV—0046(Vol.3), pp 93-103) **Overview of solar thermal electric systems environmental issues.** Lindberg, R.G. (Univ. of California, Los Angeles). Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

Attractive features of solar energy for production of electricity include an inexhaustible and virtually free energy source as well as very minimal impacts on air quality relative to conventional power plants. The two major applications of STPS technologies are: (1) large scale (300 to 500 MWe), centralized receiver systems; and (2) smaller scale (0.5 to 10 MWe), dispersed receiver systems applicable for either or both electric power generation and heat production. Environmental concerns vary significantly with the application. Large scale centralized STPS are land, water, and capital intensive. Major environmental concerns derive from siting such facilities in southwestern deserts. The principal environmental concerns are for potentially irreversible ecological impacts in the vicinity of STPS sites, and worker safety on-site. The primary siting constraint will be availability of water. Smaller scale, dispersed receiver, STPS are likely to be located near areas already developed for agriculture or industry. The primary environmental concern will be public safety and protection of property. The primary siting constraint will be institutional barriers associated with land use, zoning, utility interfaces, etc. Representative areas requiring further assessment are handling and disposal of system fluids and wastes; consequences and mitigation of accidental releases of working fluids; consequences and mitigation of normal and misdirected heliostat reflection; possible alterations of local ecosystems and microclimates near heliostat fields; and socioeconomic and institutional constraints to adoption of STPS technology.

2729 (DOE/EV—0046(Vol.3), pp 105-120) **Eye hazards associated with central receiver heliostat arrays.** Brumleve, T.D. (Sandia Labs., Livermore, CA). Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

Potential eye hazards associated with reflected light from the heliostat arrays of central receiver power plants have been investigated analytically and experimentally. Techniques were developed for measuring image sizes and irradiance levels relative to safe exposure limits for the human retina at various distances for single and multiple heliostate beams. Results of experimental measurements in single beams are given for four different types of heliostats at Sandia Livermore. Multiple beam measurements were made by means of helicopter flights over the Solar Thermal Test Facility heliostat array at Sandia Albuquerque. Potential exposure levels for aircraft personnel above minimum altitudes specified by general FAA rules were found to be well within safe limits.

2730 (DOE/EV—0046(Vol.3), pp 197-222) **Environmental and safety considerations for solar heating and cooling applications.** Waksman, D. Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

The HUD Minimum Property Standards (MPS) and the residential and commercial interim performance criteria (IPC) prepared by the National Bureau of Standards address many health and safety considerations that need to be considered by solar heating and cooling system designers. For example, factors such as the toxicity and flammability of heat transfer fluids are often not considered in the design of systems. Similarly, attention is seldom paid to the safe disposal of these fluids. These problems are compounded by the lack of clear guidelines as to which fluids constitute hazards that warrant special consideration. This report is intended to create an increased sense of awareness of the health and safety aspects of solar heating and cooling applications by extracting and amalgamating pertinent provisions of the MPS and IPC documents. Some of the areas that are addressed include: structural safety, heat transfer fluid toxicity and flammability considerations including the protection of potable water, effects of solar equipment on the fire resistance of buildings, and protection from physical hazards.

2731 (NBSIR—79-1705) **State solar energy legislation of 1977: a review of statutes relating to buildings.** Eisenhard, R.M.; Santucci, L.A. (National Bureau of Standards, Washington, DC (USA). Center for Building Technology). Feb 1979. 395p. Dep. NTIS, PC A17/MF A01.

State legislation enacted in 1977 on solar energy as applied to buildings is reviewed. Acts involve tax incentives, sun rights, standards for solar units, and State support or promotion of solar research, solar demonstrations, and solar loans. The Acts are identified and abstracted, and responsible State agencies and officials identified. The Acts, supporting forms and other documents are included in the Appendices.

2732 (SERI/TR—62-274) **Utility rates and service policies as potential barriers to the market penetration of decentralized solar technologies.** Feuerstein, R.J. (Solar Energy Research Inst., Golden, CO (USA)). Aug 1979. Contract EG-77-C-01-4042. 131p. Dep. NTIS, PC A07/MF A01.

At present, economic and institutional concerns dictate that decentralized solar technologies generally require an auxiliary energy source to assure continuous service through periods of adverse weather. Utility rates and service policies regarding auxiliary energy service have a significant impact upon solar system economics, and thus the commercialization of solar energy. The scope of this paper evaluates three basic issues: (1) whether a utility can refuse to provide auxiliary service to solar users, (2) whether a utility can charge higher or lower than traditional rates for auxiliary service, and (3) whether a utility can refuse to purchase excess power generated by small power producers utilizing electricity-producing solar technologies. It appears that a utility cannot refuse to provide auxiliary service to a solar user unless the company can demonstrate that to provide such service, substantial harm would result to its existing customers. Statutes or case decisions also provide that utilities cannot unreasonably discriminate in rates charged to customers for the same service under like conditions. The ability of a utility to provide solar users lower than traditional rates may depend upon the jurisdiction's view of promotional rates. 681 references.

2733 **Impact of solar energy in buildings upon electric utilities.** Abrash, M.; Feldman, S.L.; Howard, R.A.; Wessler, E.; Wirtshafter, R.M. Sacramento, CA; California Energy Commission (1979). 128p. (NP—24117).

It is concluded that: the reduction in kW demands observed for various passive and active solar energy designs illustrates that building design, energy conservation measures, and solar space and water heating systems were significant. For example, new insulation standards reduce a building's peak demand by 1.7 kW. The use of solar energy in a building could result in a reduction of .53 to 1.14 kW. To the extent the utility anticipates reductions in peak kW demand as a result of consumer investment in solar energy and/or conservation measures, real savings in capacity and costs will be obtained. Homeowners can accrue significant savings under Pacific Gas and Electric Company's experimental time-of-use rates. In the Los Angeles Department of Water and Power area, investments in solar energy systems and conservation measures may be less likely under time-of-use rates.

SOLAR ENERGY CONVERSION

2734 **A/sup I//sub 1-y/B/sup I//sub y/C/sup III/D/sup VI//sub 2x/E/sup VI//sub(21-x/) pentenary alloy system and its application to photovoltaic solar energy conversion.** Shewchun, J.; Loferski, J.; Beaulieu, R.; Chapman, G.H.; Garside, B.K. (Department of Engineering Physics and Physics, McMaster University, Hamilton, Ontario, Canada L89 4M1). *J. Appl. Phys.;* **50**: No. 11, 6978-6985(Nov 1979).

This paper reports work on pentenary alloy systems similar to the quarternary system in In/sub 1-x/Ga/sub x/P/sub 1-y/As/sub y/. Such A/sup I//sub 1-y/B/sup I//sub y/C/sup III/D/sup VI//sub 2x/E/sup VI//sub(21-x/) and A/sup II//sub 1-y/B/sup II//sub y/C/sup IV/D/sup V//sub 2x/E/sup V//sub(21-x/) pentenary alloys are mixtures of ternary chalcopyrites of the I-III-VI_2 and II-IV-V_2 variety. These materials are of interest because their use can improve the performance of heterojunction electro-optic devices such as solar cells. This improvement arises because the pentenaries can permit different semiconductor layers to be deposited upon each other such that they are lattice and crystallographically matched, but at the same time have independently adjustable band gaps. More specifically, we have focused on the Cu/sub 1-y/Ag/sub y/InS/sub(21-x/)Se/sub 2x/ system which appears to have the best potential of all the possible systems for solar energy applications. Samples were prepared by reacting stoichiometric powder mixtures at about 900 °C. X-ray diffractometry indicated complete solid solubility over the whole compositional range. Cathodoluminescence was used to determine band gaps at 300 and 77 °K and the spectra indicate that all alloys are direct-band-gap semiconductors. Isolattice constant and band-gap contour maps for the system have been obtained.

PHOTOVOLTAIC CONVERSION

REFER ALSO TO CITATION(S) 2719, 2727, 2732, 2790, 2792, 2866

2735 (CONF-790595—) **Proceedings of the US DOE Photovoltaics Technology Development and Applications Program Review.** (Jet Propulsion Lab., Pasadena, CA (USA)). 1979. 556p. Dep. NTIS, PC A24/MF A01.

From DOE semi-annual review for photovoltaics; Gatlinburg, TN, USA (16 May 1979).

This report of the Proceedings of the US DOE Photovoltaics Technology Development and Applications Program Review has been assembled to provide the participants and other interested parties with a compilation of abstracts of the 40 talks given. Copies of visual aids and photographs used have been printed in the best available form.

2736 (CONF-790595—, pp 1.1-1.8) **US Department of Energy multi-year program plan.** San Martin, R.L. (US Dept. of Energy, Washington, DC). 1979.

From DOE semi-annual review for photovoltaics; Gatlinburg, TN, USA (16 May 1979).

2737 (CONF-790595—, pp 2.1-2.7) **Photovoltaic mission analysis.** Leonard, S.L. (Aerospace Corp., El Segundo, CA). 1979.

From DOE semi-annual review for photovoltaics; Gatlinburg, TN, USA (16 May 1979).

2738 (CONF-790595—, pp 2.8-2.15) **Stand-Alone Applications Project.** Palmer, R.S. (Lewis Research Center, Cleveland, OH). 1979.

From DOE semi-annual review for photovoltaics; Gatlinburg, TN, USA (16 May 1979).

2739 (CONF-790595—, pp 2.16-2.50) **Overview of PV field tests and PV/thermal project activities at MIT Lincoln Laboratory.** Pope, M.D. (Massachusetts Inst. of Tech., Lexington). 1979.

From DOE semi-annual review for photovoltaics; Gatlinburg, TN, USA (16 May 1979).

2740 (CONF-790595—, pp 2.53-2.62) **Planning and analysis for development and commercialization of photovoltaic energy conversion systems (demand and decision analysis).** Tabors, R.D. (Massachusetts Inst. of Tech., Cambridge). 1979.

From DOE semi-annual review for photovoltaics; Gatlinburg, TN, USA (16 May 1979).

2741 (CONF-790595—, pp 2.63-2.79) **Sandia Laboratories photovoltaics projects overview.** Shafer, B.D.; Jones, G.J.; Burgess, E.L. (Sandia Labs., Albuquerque, NM). 1979.

From DOE semi-annual review for photovoltaics; Gatlinburg, TN, USA (16 May 1979).

2742 (CONF-790595—, pp 2.80-2.91) **Low-Cost Solar Array Project. Progress summary, November 1978-May 1979.** Callaghan, W.T. (Jet Propulsion Lab., Pasadena, CA). 1979.
From DOE semi-annual review for photovoltaics; Gatlinburg, TN, USA (16 May 1979).

2743 (CONF-790595—, pp 2.92-3.3) **Advanced research and development status.** Feucht, D.L. (Solar Energy Research Inst., Golden, CO). 1979.
From DOE semi-annual review for photovoltaics; Gatlinburg, TN, USA (16 May 1979).

2744 (CONF-790595—, pp 3.4-3.16) **Photovoltaic system price goals.** Smith, J.L. (Jet Propulsion Lab., Pasadena, CA). 1979.
From DOE semi-annual review for photovoltaics; Gatlinburg, TN, USA (16 May 1979).

2745 (CONF-790595—, pp 3.17-3.26) **International plan for photovoltaics: development activities.** Carpenter, P.R. (Jet Propulsion Lab., Pasadena, CA). 1979.
From DOE semi-annual review for photovoltaics; Gatlinburg, TN, USA (16 May 1979).

2746 (CONF-790595—, pp 3.27-3.32) **Implementation planning.** Easter, R. (Jet Propulsion Lab., Pasadena, CA). 1979.
From DOE semi-annual review for photovoltaics; Gatlinburg, TN, USA (16 May 1979).

2747 (CONF-790595—, pp 3.33-3.49) **Highlights of the May 1979 Draft Residential Application Implementation Plan.** Kern, E.C. Jr. (Massachusetts Inst. of Tech., Lexington). 1979.
From DOE semi-annual review for photovoltaics; Gatlinburg, TN, USA (16 May 1979).

2748 (CONF-790595—, pp 3.50-3.64) **Preliminary intermediate application implementation planning.** Burgess, E.L. (Sandia Labs., Albuquerque, NM). 1979.
From DOE semi-annual review for photovoltaics; Gatlinburg, TN, USA (16 May 1979).

2749 (CONF-790595—, pp 3.75-3.81) **Status of DOE-TD and A stand-alone applications implementation plan.** Deyo, J.N. (Lewis Research Center, Cleveland, OH). 1979.
From DOE semi-annual review for photovoltaics; Gatlinburg, TN, USA (16 May 1979).

2750 (CONF-790595—, pp 4.2-4.7) **Status report: performance criteria and test standards for photovoltaic systems.** DeBlasio, R. (Solar Energy Research Inst., Golden, CO). 1979.
From DOE semi-annual review for photovoltaics; Gatlinburg, TN, USA (16 May 1979).

2751 (CONF-790595—, pp 4.8-4.19) **Brief review of photovoltaic systems for residential applications.** Jones, G.J. (Sandia Labs., Albuquerque, NM). 1979.
From DOE semi-annual review for photovoltaics; Gatlinburg, TN, USA (16 May 1979).

2752 (CONF-790595—, pp 4.20-4.31) **Summary of photovoltaic intermediate application analyses.** Biringer, K.L.; Burgess, E.L. (Sandia Labs., Albuquerque, NM). 1979.
From DOE semi-annual review for photovoltaics; Gatlinburg, TN, USA (16 May 1979).

2753 (CONF-790595—, pp 4.43-4.53) **Balance of system requirements.** Jones, G.J. (Sandia Labs., Albuquerque, NM). 1979.
From DOE semi-annual review for photovoltaics; Gatlinburg, TN, USA (16 May 1979).

2754 (CONF-790595—, pp 4.54-4.63) **1979 power conditioning workshop highlights.** Smith, D.R. (Sandia Labs., Albuquerque, NM). 1979.
From DOE semi-annual review for photovoltaics; Gatlinburg, TN, USA (16 May 1979).

2755 (CONF-790595—, pp 4.84-4.92) **Control of PV power systems: AM radio station.** Much, C.H. (Massachusetts Inst. of Tech., Lexington). 1979.
From DOE semi-annual review for photovoltaics; Gatlinburg, TN, USA (16 May 1979).

2756 (CONF-790595—, pp 4.93-4.106) **Photovoltaic power conditioning and storage.** Millner, A.R. (Massachusetts Inst. of Tech., Lexington). 1979.
From DOE semi-annual review for photovoltaics; Gatlinburg, TN, USA (16 May 1979).

2757 (CONF-790595—, pp 4.107-4.116) **Comparing observed and simulated photovoltaic system performance.** Grossman, B.L. (Massachusetts Inst. of Tech., Lexington). 1979.
From DOE semi-annual review for photovoltaics; Gatlinburg, TN, USA (16 May 1979).

2758 (CONF-790595—, pp 4.117-4.124) **Flat plate photovoltaic system cost study.** Fletcher, G.; Jacobson, E.; Williams, F. (Georgia Inst. of Tech., Atlanta). 1979.
From DOE semi-annual review for photovoltaics; Gatlinburg, TN, USA (16 May 1979).

2759 (CONF-790595—, pp 4.125-4.135) **Batteries for specific solar applications.** Clark, R.P. (Sandia Labs., Albuquerque, NM). 1979.
From DOE semi-annual review for photovoltaics; Gatlinburg, TN, USA (16 May 1979).

2760 (CONF-790595—, pp 5.2-5.21) **Photovoltaic concentrator project.** Shafer, B.D. (Sandia Labs., Albuquerque, NM). 1979.
From DOE semi-annual review for photovoltaics; Gatlinburg, TN, USA (16 May 1979).

2761 (CONF-790595—, pp 5.22-5.49) **Low-Cost Solar Array Project: flat plate photovoltaic ingot technology and production process equipment.** Callaghan, W.T.; Koliwad, K.M.; Bickler, D.B. (Jet Propulsion Lab., Pasadena, CA). 1979.
From DOE semi-annual review for photovoltaics; Gatlinburg, TN, USA (16 May 1979).

2762 (CONF-790595—, pp 6.2-6.32) **Status report on PRDA 35 and 38 system applications experiments.** Burgess, E.L. (Sandia Labs., Albuquerque, NM). 1979.
From DOE semi-annual review for photovoltaics; Gatlinburg, TN, USA (16 May 1979).

2763 (CONF-790595—, pp 6.33-6.41) **Small village power applications: Schuchuli/Upper Volta.** Ratajczak, A.F. (Lewis Research Center, Cleveland, OH). 1979.
From DOE semi-annual review for photovoltaics; Gatlinburg, TN, USA (16 May 1979).

2764 (CONF-790595—, pp 6.42-6.52) **Natural Bridges National Monument 100 kW photovoltaic power system.** Solman, F.J. (Massachusetts Inst. of Tech., Lexington). 1979.
From DOE semi-annual review for photovoltaics; Gatlinburg, TN, USA (16 May 1979).

2765 (CONF-790595—, pp 6.53-6.61) **Status report on 25 kW photovoltaic power generation experiment at Mead, Nebraska.** Forman, S.E. (Massachusetts Inst. of Tech., Lexington). 1979.
From DOE semi-annual review for photovoltaics; Gatlinburg, TN, USA (16 May 1979).

2766 (CONF-790595—, pp 6.62-6.71) **Photovoltaic/thermal collector project status.** Russell, M.C. (Massachusetts Inst. of Tech., Lexington). 1979.
From DOE semi-annual review for photovoltaics; Gatlinburg, TN, USA (16 May 1979).

2767 (CONF-790595—, pp 6.72-6.78) **SOLERAS program and the Saudi Arabian village power system.** Lowenstein, M.Z. (Solar Energy Research Inst., Golden, CO). 1979.
From DOE semi-annual review for photovoltaics; Gatlinburg, TN, USA (16 May 1979).

2768 (CONF-790595—, pp 6.79-6.89) **Mississippi County Community College total energy and Northwest Mississippi Junior College test bed photovoltaic applications.** Golay, A. (TEAM, Inc., Springfield, VA). 1979.
From DOE semi-annual review for photovoltaics; Gatlinburg, TN, USA (16 May 1979).

2769 (CONF-790595—, pp 6.90-6.103) **Military applications of photovoltaic systems.** Faehn, D.D. (US Army Mobility Equipment Research and Development Command, Fort Belvoir, VA). 1979.
From DOE semi-annual review for photovoltaics; Gatlinburg, TN, USA (16 May 1979).

2770 (CONF-790595—, pp 8.1-8.12) **Federal photovoltaic utilization program.** Santopietro, R.F. 1979.
From DOE semi-annual review for photovoltaics; Gatlinburg, TN, USA (16 May 1979).

2771 (CONF-790595—, pp 8.16-8.30) **Market definition study of photovoltaic power for remote villages in the United States and possessions.** Ragsdale, C.; Quashie, P. 1979.
From DOE semi-annual review for photovoltaics; Gatlinburg, TN, USA (16 May 1979).

2772 (DOE/JPL/954355—3) **Large area silicon sheet by EFG. Annual progress report, October 1, 1977-September 30, 1978.** Wald, F.V. (Mobil Tyco Solar Energy Corp., Waltham, MA (USA)). 16

Feb 1979. Contract NAS-7-100-954355. 78p. Dep. NTIS, PC A05/MF A01.

Progress in EFG ribbon growth was made in a number of areas as follows: (1) Multiple growth for ribbons 5 cm in width was demonstrated in two runs of 12 and 20 hours' duration. (2) A new single cartridge crystal growth station, designated Machine 17, was built. It has vastly expanded observational capacity by virture of an anamorphic optical-video system which allows close observation of the meniscus over 7.5 cm in width, as well as video taping of the ribbon growth process for further analysis. Also, a number of mechanical advances were incorporated into this equipment. (3) Growth Station No. 1 achieved reproducible and reliable growth of 7.5 cm wide ribbon at speeds up to 4 cm/min. (4) A major advance in cartridge design, the mini cold shoe, was introduced. (5) Interface shaping using the displaced die concept led to significant increases in cell efficiency. Large area cells (2.5 by 7.5 cm^2, 2.5 x 10 cm^2, and 7.5 by 7.5 cm^2), which achieve efficiencies over 9%, have been made in significant numbers. (6) The role of gaseous impurities in cartridge furnaces has been clarified and their destabilizing influence on growth has been brought under control. Details of most of these developments are discussed.

2773 (DOE/JPL/954995—3) **Develop silicone encapsulation systems for terrestrial silicon solar arrays. Interim report, February 15-December 31, 1978.** (Dow Corning Corp., Midland, MI (USA)). Mar 1979. Contract NAS-7-100-954995. 79p. Dep. NTIS, PC A05/MF A01.

The technical approach of the contract effort is divided into four sequential tasks: (1) Technology review - a review of: (a) the performance of clear silicone and modified silicone materials subjected to extended periods of outdoor weathering; (b) the experience of the photovoltaic industry using silicone encapsulants; (c) the industrial experience of protecting electronic devices with silicone materials; (d) The test results of weathering silicone-based protective coatings. (2) Generation of concepts for screening and processing silicone encapsulation systems; (a) selection of the most appropriate current silicone and silicone-based coatings for the intended application; (b) identification of viable encapsulation systems and potentially cost effective materials of fabrication; (c) selection of stress tests for the encapsulation concepts; (d) ranking of the encapsulation concepts based on their performance in the screening tests. (3) Assessment of encapsulation concepts: (a) fabrication of mini-modules using state-of-the-art technologies and the best encapsulation concepts from the screening test; (b) dabulation and ranking of the test esults based on performance, cost and processability. (4) Evaluation of encapsulation concepts: mini-modules designed to TPL specifications and utilizing the highest ranked concepts from 3 (b) will be built, stressed and evaluated. The status of the project is described in detail.

2774 **V-groove multijunction solar cells.** Chappell, T.I. Berkeley, CA; University of California (1978). 130p. University Microfilms Order No. 79-04,404.

Thesis (Ph. D.).

Chapter 1 describes a new family of silicon photovoltaic devices called V-Groove Multi-Junction (VGMJ) solar cells. The VGMJ solar cells consist of an array of many individual diode elements connected in series to produce a high voltage, low current output. The elements of a cell are formed simultaneously from a single silicon wafer by V-groove etching. The results of detailed computer simulations predict a conversion efficiency in excess of 24% for one of these devices, the Type VI VGMJ solar cell, when it is operated in sunlight concentrated 100 or more times. Also present in Chapter 1 are the details of the fabrication procedure for the Type VI VGMJ solar cell along with a discussion of the factors considered in selecting the processing parameters for each step. The results of measurements which characterize the doping profiles, spectral response, dark and illuminated I-V characteristics, and bulk carrier lifetime of prototype cells are given. Chapter 2 discusses the design of a silicon sensor intended for use in rapid-scan solar flux mapping at high illumination intensities. In Chapter 3, the characteristics of a water absorber in front of a silicon solar cell are quantified through the use of computer simulations and measurements. The results show that a water layer positioned between the sun and a silicon solar cell can provide a substantial thermal output without seriously reducing the electrical output.

2775 (LBL—8580, pp 449-451) **Solar energy.** 1978.

In Materials and Molecular Research Division annual report, 1978.

Research topics discussed include growth of heteroepitaxial films of CdS and (Cd,Zn)S on GaAs and Ge substrates, transmission electron microscopy observation of structural defects in single crystal and polycrystalline CdS and (Cd,Zn)S films, and electrical, optical, and structural characterization of CdS-Cu/sub x/S and (Cd,Zn)S-Cu/sub x/S heterojunctions. 1978 publications and reports are listed. (WHK)

2776 **Molybdenum trioxide (MoO_3)/silicon photodiodes.** Osterwald, C.; Cheek, G.; DuBow, J.B.; Verneker, V.R.P. (Department of Electrical Engineering, Colorado State University, Fort Collins, Colorado 80523). *Appl. Phys. Lett.;* **35**: No. 10, 775-776(15 Nov 1979).

Molybdenum trioxide (MoO_3) has been deposited onto single-crystal p-type silicon by neutralized ion-beam sputter techniques. The results indicate that the diode behavior is a function of oxygen partial pressure during the reactive sputtering. Film thickness, deposition rate, index of refraction, resistivity, and integrated transmission have been measured under AM1 illumination. It appears that thin films of MoO_3 could serve as an n-type transparent semiconductor for photovoltaic applications.

2777 **Fabrication on a laboratory scale and mechanical properties of Cu-Nb-Sn multifilamentary superconducting composite wires produced by cold powder metallurgy processing.** Fluekiger, R.; Akihama, R.; Foner, S.; McNiff, E.J. Jr.; Schwartz, B.B. (Francis Bitter National Magnet Laboratory and Plasma Fusion Center, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Appl. Phys. Lett.;* **35**: No. 10, 810-812(15 Nov 1979).

Superconducting Cu-Nb-Sn multifilamentary composites are fabricated inexpensively on a laboratory scale. Small (40 μm) particles of Cu and Nb are compacted, placed in a suitable external jacket for containment, then elongated at room temperature to form a multifilamentary circular wire. Processing yields a multifilamentary Cu-Nb-Sn superconductor with high overall critical current densities J/sub c/ at high magnetic fields. Measurements of the mechanical properties show no degradation of J/sub c/ for strains greater than 1% for composite made with a large areal reduction ratio.

2778 **Efficiency of quantum-utilizing solar energy converters in the absence of intraband thermalization.** Ross, R.T. (The Ohio State University, 484 West 12th Avenue, Columbus, Ohio 43210). *Appl. Phys. Lett.;* **35**: No. 9, 707-708(1 Nov 1979).

In some photoelectrical and photochemical devices, energy conversion may occur before thermal equilibrium within the electronic bands of the absorber. A statistical thermodynamic argument shows that such hot-transfer devices cannot have an efficiency greater than that of an ideal device in which thermalization precedes energy conversion.

2779 **AlGaAs tunnel diode.** Bedair, S.M. (Research Triangle Institute, Research Triangle Park, North Carolina 27709). *J. Appl. Phys.;* **50**: No. 11, 7267-7268(Nov 1979).

An AlGaAs tunnel diode with a band gap of 1.6 eV has been fabricated. This diode provides a suitable connecting junction between the high- and low-band gap cells of a cascade solar-cell structure operating at several hundred suns concentration without causing any appreciable loss in efficiency.

2780 (SAND—78-7040(Vol.1)(Exec.Summ.)) **Regional conceptual design and analysis studies for residential photovoltaic systems.** Pittman, P.F.; Federmann, E.F.; Brodzik, M.; McAllister, W.J.; Stoeltzing, R.W.; Nearhoof, S.; Rittelmann, P.R. (Westinghouse Electric Corp., Pittsburgh, PA (USA). Research and Development Center). Sep 1979. Contract EY-76-C-04-0789. 51p. Dep. NTIS, PC A04/MF A01.

Solar residential photovoltaic energy systems, suitable for incorporation into single-family residences and typical of future construction practices, were studied. The country was subdivided into ten regions, and the three best systems for each region were determined from the many possible system configurations. Cost projections based on high volume production indicated that solar total energy systems would be viable. If a sufficiently comprehensive government program is forthcoming, they can be economically advantageous in some areas within 10 years and in many areas of the country by 2000. Achievement of the goals described in this study will result in 6 to 12% of the residential energy demand (and about 2 to 4% of the total demand) being supplied by the sun by the year 2000. The three best system configurations found independent of the specific sites are those with combined electrical/thermal modules; electrical-only modules with a heat pump; and possibly, separate side-by-side electrical and thermal arrays. Order of preference is determined by the site/structure characteristics. In general, systems were assumed to include battery storage. Non-storage systems employing energy sellback to the utility were assumed only in the very early, low penetration stages. This volume contains a summary of the results of the study, and includes a brief discussion of some of the factors that led to these results.

2781 **Solar cell with improved N-region contact and method of forming the same.** Frosch, R.A.; Bube, K.R. US Patent 4,163,678. 7 Aug 1979. Filed date 30 Jun 1978. 4p.

A method for forming an improved silicon solar cell having a shallow N-type region and a contact characterized by reduced contact resistance is described. The cell is characterized by a silicon semiconductor wafer of P-type material in which a shallow region of N-type material has been diffused. A sintered silver contact formed from silver powder and silver metaphosphate is affixed to the N-type

region, establishing a region of increased carrier concentration. Commercial techniques for depositing contacts on the N-type region are briefly reviewed.

2782 **GaAs-GaAlAs solar cells.** Kamath, G.S.; Anderson, C.L. (to Hughes Aircraft Co.). US Patent 4,163,987. 7 Aug 1979. Filed date 2 May 1977. 6p.

An improved III-V compound solar cell structure and fabrication process is described wherein a P-type layer of gallium aluminum arsenide is epitaxially grown on an N-type gallium arsenide substrate to form a P-type region and a PN junction in the substrate. Controlled amounts of beryllium are introduced into both the epitaxial layer and the substrate, either during epitaxial growth or by using beryllium ion implantation techniques subsequent to the P-type epitaxial growth step. The homojunction-heterostructure device thus formed exhibits improved power conversion efficiencies in excess of 17%. 2 claims.

2783 **Voltage-current-power meter for photovoltaic solar arrays.** Ross, R.G. (to California Inst. of Tech.). US Patent 4,163,194. 31 Jul 1979. Filed date 22 Jul 1977. 12p.

A portable meter is described for measuring the voltage, current, and power (VIP) parameters of a photovoltaic solar array, or array module, under sunlight operating conditions. The meter utilizes a variable load connected across the array and controlled by a voltage regulator which responds to the difference between the output voltage of the array and a programmed test voltage from a source which generates a single ramp voltage for measuring and recording current as a function of voltage, repeated ramp voltages at a high rate for peak output measurements of a DC voltage for VIP measurements at selected points on the I-V characteristic curve of the array. An analog multiplier multiplies the array voltage and normalized current to provide a measurement of power. Switches are provided to selectively connect the power, P, current, I, or voltage, V, to a meter, directly or through a peak detector. At the same time any one of the parameters V, I, and P may be recorded as a function of any other parameter.

2784 **Luminescent solar collector.** Wohlmut, P.G.; Yerkes, J.W. (to Atlantic Richfield Co.). US Patent 4,155,371. 22 May 1979. Filed date 25 Sep 1978. 6p.

A luminescent solar collector is disclosed having a luminescent member with at least two types of photovoltaic cells, each type of cell operating efficiently for the generation of electricity over a wavelength range which is different from the efficient wavelength range of the other types of photovoltaic cells present on the luminescent member, each type of photovoltaic cell carrying intermediate to it and the luminescent member a filter means which allows only light within the efficient wavelength range for that type of photovoltaic cell to pass from the luminescent member into the photovoltaic cell.

2785 **Luminescent solar collector.** Blieden, H.R.; Sill, R.C. (to Atlantic Richfield Co.). US Patent 4,153,813. 8 May 1979. Filed date 19 Jun 1978. 6p.

A luminescent solar collector is disclosed comprising at least one luminescent member having at least one photovoltaic means operably associated therewith. The luminescent member has a side which is to be exposed to incoming (incident) light, and a transparent member carried adjacent to the incident light side of the luminescent member, the outer exposed side of the transparent member having a roughened surface.

BIOMASS PRODUCTION AND CONVERSION

REFER ALSO TO CITATION(S) 3201, 3202

2786 (BNL—26721) **Potential of biomass conversion in meeting the energy needs of the rural populations of developing countries: an overview.** Mubayi, V.; Lee, J.; Chatterjee, R. (Brookhaven National Lab., Upton, NY (USA); State Univ. of New York, Stony Brook (USA). Inst. for Energy Research). 1979. Contract EY-76-C-02-0016. 17p. (CONF-790917—11). Dep. NTIS, PC A02/MF A01.

From American Chemical Society national meeting; Washington, DC, USA (10 Sep 1979).

A preliminary assessment is presented of the contribution biomass conversion could make in the context of the rural areas of six developing countries: India, Indonesia, Peru, Sudan, Tanzania, and Thailand. The technologies selected for analysis are: anaerobic digestion of wet biomass to produce methane and pyrolysis of dry biomass to produce charcoal, liquid fuels, and low-Btu gases. Preliminary estimates are made of the amounts of fuels that could be produced in each of the selected countries by a combination of these technologies. It was found that, with the exception of India, implementation of these technologies could potentially meet the future energy needs of their rural populations for both subsistence and development. (MHR)

2787 (DOE/EV—0046(Vol.3), pp 183-196) **Environmental aspects of wood energy conversion.** High, C.J.; Hewett, C.E. (Dartmouth College, Hanover, NH). Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

The environmental aspects of the technologies under the jurisdiction of the Fuels from Biomass Programs are presented. Positive as well as negative impacts are discussed. Some treatment is given to the specific topics of particulate and toxic substance control.

PHOTOCHEMICAL AND THERMOCHEMICAL CONVERSION

REFER ALSO TO CITATION(S) 3431

PHOTOVOLTAIC POWER PLANTS

REFER ALSO TO CITATION(S) 2735, 2737, 2746, 2749, 2753, 2792

2788 (CONF-790595—, pp 3.65-3.74) **Photovoltaic central station plan status.** Siegel, B. (Aerospace Corp., El Segundo, CA). 1979.

From DOE semi-annual review for photovoltaics; Gatlinburg, TN, USA (16 May 1979).

2789 (CONF-790595—, pp 4.32-4.42) **Central power station overview.** Jones, G.J. (Sandia Labs., Albuquerque, NM). 1979.

From DOE semi-annual review for photovoltaics; Gatlinburg, TN, USA (16 May 1979).

2790 (CONF-790595—, pp 4.64-4.83) **Structures.** Post, H.N. (Sandia Labs., Albuquerque, NM). 1979.

From DOE semi-annual review for photovoltaics; Gatlinburg, TN. USA (16 May 1979).

SOLAR THERMAL POWER PLANTS

REFER ALSO TO CITATION(S) 2728, 2729, 2792, 2887, 2888, 2889, 2890, 2892, 3586

CENTRAL RECEIVER

REFER ALSO TO CITATION(S) 3526

2791 **Solar-thermal power plant.** Seidel, A.; Wolf, D. (to Messerschmitt-Boelkow Blohm Gesellschaft mit beschraenkter Haftung). US Patent 4,167,856. 18 Sep 1979. Priority date 27 Nov 1975, German, Federal Republic of (F.R. Germany), 6p.

A solar-thermal power plant, comprises an open air circuit wherein the effective heat obtained from solar energy is supplied to the air current between a compressor and an expansion machine. The construction includes a solar heater which is exposed directly to solar radiation and which is traversed by the air current and provides a means for the direct solar heating of the air current which is conveyed from the compressor to the expansion machine.

TOTAL ENERGY AND HYBRID SYSTEMS

REFER ALSO TO CITATION(S) 2768, 2885

SOLAR RADIATION UTILIZATION

REFER ALSO TO CITATION(S) 2725

2792 (NP—24119) **Directory of solar energy research projects in India.** (Tata Energy Research Inst., Bombay (India)). 1978. 231p. Dep. NTIS (US Sales Only), PC A11/MF A01.

This directory contains data on 140 research projects in the area of Solar Thermal Conversion and Photovoltaic Processes. It includes the following: subject categories, list of institutions, list of investigators, and project information sheets. (MHR)

SPACE HEATING AND COOLING

REFER ALSO TO CITATION(S) 2730, 2731, 2732, 2766, 3098, 3102, 3198, 3199, 3274, 3275, 3276

2793 (BNL—26582) **Solar heating and hot water systems using electric backup: a case study of the utility and homeowner economics.** Bright, R.; Davitian, H. (Brookhaven National Lab., Upton, NY (USA)). 1979. Contract EY-76-C-02-0016. 10p. (CONF-790541—55). Dep. NTIS, PC A02/MF A01.

From International Solar Energy Society meeting; Atlanta, GA, USA (28 May 1979).

Utility costs of providing backup electricity for residential solar heating and hot water (HHW) systems are estimated using a utility capacity expansion model and utility financial computation techniques. These costs are compared to the cost of providing electricity for electric-only systems and to the average of all electricity generated to provide information useful for designing rates. From the estimates of utility costs, homeowner expenditures for HHW are computed for various HHW system options. This paper updates results for a case study of one actual utility.

2794 (BNL—26772) **Performance of heat pumps at elevated evaporating temperatures: with application to solar input.** Kush, E.A. (Brookhaven National Lab., Upton, NY (USA)). 1979. 9p. (CONF-791205—15). Dep. NTIS, PC A02/MF A01.

From ASME winter annual meeting; New York, NY, USA (2 Dec 1979).

As part of the study of Solar Assisted Heat Pump (SAHP) systems, the performance of the heat pump component itself under conditions attendant to series solar input is being investigated. Notably the effect of high source temperatures, for which current heat pumps are not designed, and the associated thermodynamic potential to raise peformance are of interest. Theoretical predictions, results of systematic experiments run on a special heat pump simulator, and interpretation/analysis of how high Coefficients of Performance (COP) heat pumps can be used in installed SAHP systems are presented. The latter aspect is vital for - although results have shown that substantial increase in COP can be achieved even using off-the-shelf heat pump components - the more difficult problem is supplying sufficient solar energy to the heat pump with a practical, cost-competitive system. The approach taken to the high temperature heat pump study makes the results generally applicable to any vapor compression heat pump with elevated evaporating temperatures.

2795 (CONF-781231—, pp 425-432) **Methanol-based heat pumps for storage of solar thermal energy.** Offenhartz, P.O. (EIC Corp., Newton, MA). 1979.

From 3. annual thermal energy storage contractor's information exchange meeting; Springfield, VA, USA (5 Dec 1978).

The project's goals are to design and construct a heat pump storage system based on the reaction of CH_3OH with one or more solid-state inorganic salt substrates, suitable for use in residential heating and cooling. Major tasks include: (1) carry out screening experiments with a variety of inorganic substrates, and select the optimum salt(s). Obtain thermodynamic kinetic, and heat transfer data on the optimum salt(s). In addition, obtain data on side reactions, corrosion, and cycle life. Roughly two dozen salts were screened. The reaction of anhydrous $CaCl_2$ to form solid $CaCl_2.2CH_3OH$ has been selected for further work. Thermodynamic, kinetic, and heat transfer data on this reaction have been obtained. No side reactions or corrosion of Al or Cu have been observed. Over 300 methanolation/demethanolation cycles have been carried out without apparent degradation of performance; (2) design appropriate heat exchanger(s) for solid-gas reactions. A low cost heat exchanger has been designed, based on the use of pelletized $CaCl_2$ loaded on externally finned tubes; (3) design, construct, and test both a small scale and a large scale prototype system. The small scale prototype has been constructed, and tests are now being carried out. Preliminary data indicate the unit performs as expected. Design of the large scale prototype is largely complete. Construction will be complete by July 1979, and testing will be carried out in late FY79 and early FY80.

2796 (CONF-781254—1) **Calculations of efficiency and economy of solar heating systems in Scandinavian climate.** Hoeglund, I.; Girdo, V. (Kungliga Tekniska Hoegskolan, Stockholm (Sweden). Institutionen foer Byggnadsteknik). Oct 1978. 20p. Dep. NTIS (US Sales Only), PC A02/MF A01.

From Investigation of the performance of solar heating and cooling program meeting; Palermo, Italy (Dec 1978).

Conceivable fields of application and saving possibilities up to the year 1995 are discussed - starting from energy and power requirements for different kinds of buildings and from the efficiency and distribution of solar radiation in the northern country. Since hardly any calculations of energy costs for solar heating systems in Sweden are available, calculations of efficiency and economy of different solar heating systems are made for several places in this country. The calculations are performed with a computer program, which has been developed at the Division of Building Technology at the Royal Institute of Technology, Sweden.

2797 (DOE/NASA/CR—150618) **Solar heating and cooling systems design and development (quarterly report).** (Honeywell, Inc., Minneapolis, MN (USA). Energy Resources Center). Oct 1976. Contract EX-76-A-29-1037. 83p. Dep. NTIS, PC A05/MF A01.

Progress is reported on the development of twelve prototype solar heating/cooling systems. Six of these are to be heating and six are to be heating/cooling systems, two each for single family, multi-family, and commercial applications. Schedules and technical discussions are given, along with illustrations on the progress made.

2798 (DSE—8157-T1) **Initial results of the California Testing and Inspection Program for solar equipment (TIPSE).** (California Energy Commission, Sacramento (USA)). Aug 1979. Contract EM-75-F-01-8157. 18p. Dep. NTIS, PC A02/MF A01.

The California Energy Commission has accredited seven independent test laboratories to test solar collectors. Data for 65 collector models are tabulated. Terms used in the table are defined and ways to interpret the results are discussed. (MHR)

2799 (SAN—1719-1) **Solar assisted heat pumps for the heating and cooling of buildings. Six month progress report, May 4-November 5, 1978.** (General Electric Co., Schenectady, NY (USA). Corporate Research and Development Dept.). Nov 1978. Contract ET-78-C-03-1719. 141p. (SRD—78-175). Dep. NTIS, PC A07/MF A01.

Research and development of solar assisted heat pumps for the heating and cooling of buildings is described. Phase I requires the determination of the most cost effective solar assisted heat pump (SAHP) system. The SAHP systems considered are the series, three-coil, and cascade systems with electric resistance heat backup. Four reference systems are included: standard heat pump, two-speed heat pump, straight solar system, and parallel system. Performance characteristics of all major SAHP components are determined and used in conjunction with the simulation program TRNSYS to obtain system performance for the New York heating season. Two kinds of residential heat loads representing different construction of an 1800 ft^2 house are used. Different system control and component sizing strategies are explored. Material and installation costs are obtained for SAHP components and used in life cycle costing analysis to determine the economic viability of the various systems.

2800 (SAND—78-1927) **Systems simulation and economic analysis for solar heating and cooling.** (Department of Energy, Washington, DC (USA). Office of Conservation and Solar Applications). 1978. Contract EY-76-C-04-0789. 258p. (CONF-780639—). Dep. NTIS, PC A12/MF A01.

From Analysis for solar heating and cooling; San Diego, CA, USA (27 Jun 1978).

Separate abstracts were prepared for the approximately 65 included papers. (MOW)

2801 (SAND—78-1927, pp 1-3) **Computers in the design of solar energy systems.** Duffie, J.A.; Klein, S.A.; Mitchell, J.W.; Beckman, W.A. (Univ. of Wisconsin, Madison). 1978.

From Analysis for solar heating and cooling; San Diego, CA, USA (27 Jun 1978).

The usefulness of computer simulations of solar heating experiments as compared to physical experiments is described. Some system design methods obtained by computer simulation are discussed. (MOW)

2802 (SAND—78-1927, pp 4-7) **Comparison of four solar system simulation programs in solving a solar heating problem.** Freeman, T.L. (Univ. of Wisconsin, Madison); Maybaum, M.W.; Chandra, S. 1978.

From Analysis for solar heating and cooling; San Diego, CA, USA (27 Jun 1978).

In order to compare and coordinate the development of several Department of Energy funded solar system simulation programs, two sample solar heating problems were defined and the various United States simulation program developers were requested by the Department of Energy to independently solve them. The two problems were the International Energy Agency (IEA) liquid and air solar heating problems which are also being solved by other countries as part of the IEA simulation program comparison exercise.

2803 (SAND—78-1927, pp 12-15) **Solar heating system simulation approaches: small time model vs large time model.** Nguyen, K.H. (Honeywell Energy Resources Center, Minneapolis, MN). 1978.

From Analysis for solar heating and cooling; San Diego, CA, USA (27 Jun 1978).

Depending on its purpose, a simulation of a solar heating and/or cooling system can be constructed by either of the following two approaches: (1) Based on the dynamic response of each component, a very close-to-real-life dynamic model can be established which requires very small integration time steps. This model is an excellent tool for the study of system dynamic stability and system control strategies. (2) Based on the principle of energy conservation for a steady state system, a large integration time step model can be devised. This model is used for long term performance prediction and economic studies. Most computer programs are, at the present time, incapable of performing both tasks. At Honeywell, the SUNSIM computer program was developed and designed for such flexibility.

2804 (SAND—78-1927, pp 16-18) **Hourly model for solar heating and cooling systems design and economic optimization: liquid**

system - SOLHOUSE I. Clark, J.A. (Univ. of Michigan, Ann Arbor); Nabozny, R.L. 1978.

From Analysis for solar heating and cooling; San Diego, CA, USA (27 Jun 1978).

The simulation of solar heating and cooling systems is a valuable and convenient tool for determining systems performance. Combined with economic cost information such simulation processes can also be used to compute total operating and ownership costs, thus establishing a minimum, which is often taken to be the optimum. The various models available can be classified according to the smallest period of time considered in the calculations. Thus, the models are generally identified as annual, monthly and hourly. The hourly model is the most flexible, permitting a wider range of variables to be considered and is the only one that provides for a complete determination of storage response. Further, the solar input can be dealt with in fine detail, hourly or, in some cases, for shorter time periods. Hourly simulation, furthermore, although in more expensive of the different models to use, can be used to check and authenticate the validity of the other models.

2805 (SAND—78-1927, pp 25-29) **System performance predictions for solar cooling using stochastic weather models.** Anand, D.K.; Bazques, E.O.; Abarcar, R.B.; Allen, R.W. (Univ. of Maryland, College Park). 1978.

From Analysis for solar heating and cooling; San Diego, CA, USA (27 Jun 1978).

The study includes diverse climatic regions of the United States. The study is performed using a larger system simulation that features load calculations and hot storage as well as automatic controls to turn pumps on and off or to open and shut valves at various locations along the system network. A schematic of the system is given.

2806 (SAND—78-1927, pp 30-32) **Approximations for solar energy calculations.** Shramek, G. (Sunshine Power Co., San Jose, CA). 1978.

From Analysis for solar heating and cooling; San Diego, CA, USA (27 Jun 1978).

Portable calculators, as well as personal computers, assist engineers and architects tackling day-to-day solar energy system designs and site evaluations for less cost and with greater convenience than using consulting services or large computer systems. In developing solar energy programs for the Hewlett-Packard HP-67/HP-97 and the Texas Instruments TI-59/PC-100A, it was necessary to develop approximations to 1) describe data which had not been committed to formulas, 2) develop simple formulas for the limited memory of portable calculators and 3) reduce the running time on these slower machines. Three classes of approximations were developed and compared to available methods in the literature: 1) Hourly distribution of diffuse and total solar radiation on a horizontal surface from the daily solar radiation on a horizontal surface. 2) Daily total solar radiation and collected energy from hourly values. 3) Angular transmissivity and absorptivity from normal values.

2807 (SAND—78-1927, pp 43-45) **SUNSYM: solar thermal systems design programs.** Lydon, R.T. (Sunsearch, Inc., Guilford, CT); Barber, E.M. Jr.; Loope, R. 1978.

From Analysis for solar heating and cooling; San Diego, CA, USA (27 Jun 1978).

This is an interim report on SUNSYM - a collection of solar-thermal related computer programs currently under development by Sunsearch, Inc. SUNSYM is currently being used as a design tool for sizing components of low temperature solar thermal systems. Utimately it is expected to be developed as a design tool for complete solar thermal systems. This paper includes some background information on SUNSYM, a brief listing of current program capabilities; and some discussion of the direction of future developments.

2808 (SAND—78-1927, pp 78) **Policy applications and limitations of solar economic studies.** Roseman, E. (Dept. of Energy, Washington, DC); Babcock, W.H. 1978.

From Analysis for solar heating and cooling; San Diego, CA, USA (27 Jun 1978).

2809 (SAND—78-1927, pp 91-92) **Survey of currently used simulation tools.** Lowery, G.W. (Science Applications, Inc., McLean, VA); Versteegen, P.L.; Cassel, D.E. 1978.

From Analysis for solar heating and cooling; San Diego, CA, USA (27 Jun 1978).

2810 (SAND—78-1927, pp 93-96) **Solar system simulation using hybrid computation.** Wood, R.A. 1978.

From Analysis for solar heating and cooling; San Diego, CA, USA (27 Jun 1978).

Applications of hybrid computers to solar and building systems simulation programs is investigated. Two types of hybrid computers are discussed: an automatic patching analog/hybrid, and a special purpose digital/hybrid. The special purpose digital/hybrid, a relatively new concept, is composed of a general purpose computer acting as host to a simulation oriented, multiprocessor digital computer. An interactive user oriented analog/hybrid program for solar and building system simulation is presented. It is concluded that hybrid computer can significantly reduce solar and building systems simulation costs.

2811 (SAND—78-1927, pp 97-99) **Achieving speed and accuracy in solar simulation computer programs.** Heldt, R.W. (G.K. Associates, Newton, MA). 1978.

From Analysis for solar heating and cooling; San Diego, CA, USA (27 Jun 1978).

2812 (SAND—78-1927, pp 103-105) **Dynamic solar heating and control system model and simulation: a new design tool.** Pejsa, J.H. (Honeywell Energy Resources Center, Minneapolis, MN). 1978.

From Analysis for solar heating and cooling; San Diego, CA, USA (27 Jun 1978).

2813 (SAND—78-1927, pp 111-113) **Tax incentive legislation for solar.** Baylon, D. (Ecotope Group, Seattle, WA). 1978.

From Analysis for solar heating and cooling; San Diego, CA, USA (27 Jun 1978).

Some evaluation criteria and procedures necessary to aid assessors and revenue departments in their analysis of solar heating systems are described. The rate of return evaluation method is described. (MOW)

2814 (SAND—78-1927, pp 114-117) **Determination of the optimal solar investment decision criterion.** Sedmak, M.R.; Zampelli, E.M. 1978.

From Analysis for solar heating and cooling; San Diego, CA, USA (27 Jun 1978).

In order to highlight the differences between the three investment decision criteria discussed, a comparison of the timing of and net social benefits derived from investments in a residential solar space and water heating system made under the positive NPV criterion, the socially optimal present cost effectiveness criterion, and the payback criterion is provided. A modified version of the F-Chart design optimization program is used in the quantitative analyses. The preliminary results of this effort are summarized.

2815 (SAND—78-1927, pp 118-120) **Simulation analysis of the impact of solar heating and cooling on electric utility service areas.** Cretcher, C.K.; Waldron, R.J. (Aerospace Corp., El Segundo, CA). 1978.

From Analysis for solar heating and cooling; San Diego, CA, USA (27 Jun 1978).

The installation of solar heating and cooling (SHAC) systems usually requires a backup system - often electric - to take some portion of the load on days of low insolation and, perhaps, to carry the entire load during extended periods of low insolation. The impact of the widespread implementation of such systems on the electric utilities results in a change in utility costs that is an important variable in the overall analysis of SHAC economics. The estimation of the magnitude of this impact and the definition of preferred SHAC systems when both the utility and the customer are considered, were the objectives of a recent study by the Aerospace Corporation for the Electric Power Research Institute (EPRI). The analysis methodology applied in this study is given.

2816 (SAND—78-1927, pp 121-123) **FCHART version 3.0: current status of the University of Wisconsin computer program for solar heating design.** Hughes, P.J. (Science Applications Inc., McLean, VA). 1978.

From Analysis for solar heating and cooling; San Diego, CA, USA (27 Jun 1978).

The f-chart design method has been developed to size components of the solar heating systems. The effect of collector type and collector, storage, and heat exchanger sizes on system performance can be determined using the f-chart approach. When compared to simulation, f-chart retains all of the necessary design flexibility for the four systems shown, plus the method is simple enough for hand calculations. The FORTRAN computer program FCHART was written as a convenient tool for solar designers. Although it re-established the need for a computer, computers are already in common use by architects and HVAC engineers. Version 3.0 represents the current status of the evolving f-chart approach. Improvements since earlier versions of the program and the assumptions implicit in the use of FCHART are described.

2817 (SAND—78-1927, pp 124-126) **Solar systems sizing and analysis program.** Hunter, B.D. (Colt Inc. of Southern California, Rancho Mirage, CA). 1978.

From Analysis for solar heating and cooling; San Diego, CA, USA (27 Jun 1978).

The Colt sizing program was generated around a solar heating system utilizing Colt's liquid solar collectors incorporating a paraffinic oil heat exchanger to transfer the collected heat to a water thermal storage tank. The thermal storage water is used directly in

heating the subject building. The nominal values for the system are shown.

2818 (SAND—78-1927, pp 127-129) **SOLCOST: a solar energy design program.** Hull, D.E.; Giellis, R.T. (Martin Marietta Corp., Denver, CO). 1978.

From Analysis for solar heating and cooling; San Diego, CA, USA (27 Jun 1978).

This paper presents an overview of the following SOLCOST features: 1) analytical methodology, 2) input parameters, 3) typical results for a sample problem, 4) a summary of the validation effort to date, and 5) availability of software.

2819 (SAND—78-1927, pp 134-136) **Complete solar system design library for programmable hand-held calculators.** Winn, C.B. (Colorado State Univ., Fort Collins); Leflar, J.; Barley, C.D. 1978.

From Analysis for solar heating and cooling; San Diego, CA, USA (27 Jun 1978).

A solar system library has been developed for use on programmable hand-held calculators. The components in this library include components for determining system performance and economics, and components for proper selection of heat exchangers and for proper sizing of ducts and blowers in air systems. This paper contains brief descriptions of these programs.

2820 (SAND—78-1927, pp 146-148) **Dynamic simulation model of LiBr - H_2O.** Hoover, E.C.; Ochs, T.; Bradley, J.O. (Desert Research Inst., Boulder City, NV). 1978.

From Analysis for solar heating and cooling; San Diego, CA, USA (27 Jun 1978).

The design of solar space cooling systems which incorporate LiBr - H_2O absorption chillers is hindered by chiller manufacturer performance date which does not reflect losses in delivered cooling capacity due to machine on/off cycling. System losses due to cycling the absorption device can be partially offset by utilization of excess cooling capacity to store chilled water when cooling loads are low. Dynamic simulation models of the 3-ton ARKLA 301 and WF-36 absorption cooling units were developed which incorporate transient delays in machine start-up and enable a chilled water storage option. Computer code is compatable with the solar system simulation program TRNSYS.

2821 (SAND—78-1927, pp 149-152) **Integrated discrete-state controller model for TRNSYS.** Armstrong, P.R.; Bechtel, T. (Colorado State Univ., Fort Collins). 1978.

From Analysis for solar heating and cooling; San Diego, CA, USA (27 Jun 1978).

A single TRNSYS compatible subroutine which integrates all solar heating and cooling functions is described and an example presented. The controller functions include: (1) comparators which generate logical control criteria from analog inputs; (2) a logic element which appears to the user as a truth table transforming control criteria into a unique system operating mode; (3) a controller output generator which eliminates the need to include TRNSYS pump, tee, and divertor modules (mixer units must still be included) in the model by specifying the mass flow rates for input to the other major system components. The advantages of using the integrated TRNSYS controller module are computational efficiency and positive detection of controller state oscillation instability.

2822 (SAND—78-1927, pp 153-156) **Use of NBSLD in the design of solar and energy conserving buildings.** Barnaby, C.S.; Wilcox, B.A. (Berkeley Solar Group, CA). 1978.

From Analysis for solar heating and cooling; San Diego, CA, USA (27 Jun 1978).

NBSLD is a general purpose hour-by hour simulation model for predicting heating loads, cooling loads, and thermal conditions in buildings. The program was written at the National Bureau of Standards. It uses an hourly weather tape as data and utilizes the response factor method for calculating transient heat flows through walls. Loads and temperatures are calculated by performing an energy balance involving separate radiant and convective components of heat transfer at each surface in a space.

2823 (SAND—78-1927, pp 162-164) **Building shell element as passive solar collectors.** Dexter, N.E.; Bickle, L.W. (Bickle Division, CM, Inc., Albuquerque, NM). 1978.

From Analysis for solar heating and cooling; San Diego, CA, USA (27 Jun 1978).

A thermal network computer simulation code is described which uses first principles to calculate the thermal performance of walls under actual weather conditions. The hour-by-hour and integrated results show good comparison with experimental data. A technique is developed which uses the validated computer results to determine the efficiency with which the wall collects solar radiation. Finally, a simplified, hand calculator technique is described which can be used to make a first estimate of the solar performance and average heat load of a wall. This can be used in the design development stage on new construction to quickly evaluate the effects of various design options.

2824 (SAND—78-1927, pp 165-166) **Numerical simulation of passive solar heating systems.** Stickford, G.H. Jr.; Jakob, F.E.; Corliss, J.M. (Battelle Columbus Labs., OH). 1978.

From Analysis for solar heating and cooling; San Diego, CA, USA (27 Jun 1978).

A numerical simulation program has been developed at Battelle in order to evaluate the performance of passive solar heating systems. The method used is a finite element or network analysis approach similar to that developed by McFarland, et al, of the Los Alamos Scientific Laboratory. In this model, the system to be simulated is divided into a number of interconnected isothermal nodes. Each node is assigned a mass and specific heat and can therefore store energy.

2825 (SAND—78-1927, pp 171-174) **General design method for closed-loop solar energy systems.** Klein, S.A.; Beckman, W.A. (Univ. of Wisconsin, Madison). 1978.

From Analysis for solar heating and cooling; San Diego, CA, USA (27 Jun 1978).

This paper describes an extensive computer simulation study of a general class of closed-loop solar energy systems which can be used for a variety of applications including space heating, air conditioning, and process heating. The results of this study are presented in a convenient graphical form, referred to as anti phi, f-charts. These graphs can be used to estimate the long-term performance of closed-loop solar energy systems in a relatively simple manner. They form the basis of a general design method for a large class of solar energy systems which can provide energy for a number of different applications.

2826 (SAND—78-1927, pp 175-177) **SAHP system analysis model.** Estes, R.C.; Kahan, W. (Singer Co., Fairfield, NJ). 1978.

From Analysis for solar heating and cooling; San Diego, CA, USA (27 Jun 1978).

In the marketing of solar systems, it is necessary to identify first those regions, load profiles, and system parameters for which such systems appear promising. Because the total intersection of regional, load, and system variables is too large for testing by computer simulation, it is desirable to develop an efficient means of quickly identifying the most promising combinations and winnowing out the least promising one. To accomplish this, an analytical model of a general solar assisted heat pump (SAHP) system which permits closed form solution has been developed.

2827 (SAND—78-1927, pp 178-180) **Performance charts: a simplified solar system sizing method.** Wilcox, B.A.; Barnaby, C.S. (Berkeley Solar Group, CA). 1978.

From Analysis for solar heating and cooling; San Diego, CA, USA (27 Jun 1978).

The Performance Charts relates system size to annual solar load fraction. The method relies on two assumptions about solar applications. The first is that climate areas can be defined within which there is a uniform annual pattern of solar radiation availability. The second assumption is that for many applications an annual load pattern can be defined which specifies the fraction of the annual energy use which occurs in each calendar period.

2828 (SAND—78-1927, pp 181-183) **Designing solar energy space heating and domestic hot water heating systems using the simplified GFL method.** Lameiro, G.F. (Solar Energy Research Inst., Golden, CO). 1978.

From Analysis for solar heating and cooling; San Diego, CA, USA (27 Jun 1978).

This paper describes the development and utilization of the GFL sizing procedure for designing solar energy space and domestic hot water heating systems. It can be used for both air and liquid solar energy collectors. This method requires only the evaluation of several simple algebraic equations. A typical design example requires about five minutes to compute by hand or less than one-tenth of a second by computer. The GFL method was validated by making over 1,500 side-by-side comparisons with different collector types (air and liquid), different collector design parameters, in different locations (151 US locations), and for a range of f values from 0 to 90%. Additionaly, an independent consultant made 500 side-by-side comparisons.

2829 (SAND—78-1927, pp 184-185) **Overview of the Department of Energy's validation program.** Anand, D.K. (TPI, Inc., Beltsville, MD); Parker, A.J. Jr.; Knasel, T.M.; Bazques, E.O. 1978.

From Analysis for solar heating and cooling; San Diego, CA, USA (27 Jun 1978).

The Department of Energy has directed that as a part of the systems studies contract a task in the area of system and component validation be initiated. An overview of the tasks to be performed is given. (MOW)

2830 (SAND—78-1927, pp 190-192) **Validation of solar radiation computer models.** Lantz, L.J.; Winn, C.B. (Solar Environmental Engineering Co., Fort Collins, CO). 1978.

From Analysis for solar heating and cooling; San Diego, CA, USA (27 Jun 1978).

The purpose of this project was to develop a methodology for the validation of computer models used to predict the radiation on tilted surfaces given the similar radiation on the horizontal surface. However, the resulting methodology is not limited to just this kind of model. It has also been used to evaluate other kinds of insolation models. For example, algorithms to predict horizontal radiation from surface and cloud cover statistics; and the radiation model used in program SOLCOST which predicts the average daily total radiation for a specific surface and location using primarily the precent of possible sunshine value. The model validation methodology is presented as well as results.

2831 (SAND—78-1927, pp 193-194) **Experimental validation of the solar simulation program TRNSYS for a solar domestic hot water heating system.** Liu, S.T. (National Bureau of Standards, Washington, DC); Shih, K.; Wood, B.D. 1978.

From Analysis for solar heating and cooling; San Diego, CA, USA (27 Jun 1978).

This paper presents some of the initial results of comparisons obtained using the laboratory apparatus and associated TRNSYS simulation. The specially-designed indoor test configuration will be described. Comparison of typical test results for several different combinations of hot water use schedule, piping configuration, and assumed solar collector output with those predicted by the applicable component models in TRNSYS under similar conditions will be shown. Emphasis has been placed on comparing the degree of temperature stratification in the storage tanks.

2832 (SAND—78-1927, pp 195-197) **Field validation of the thermal performance of a passively heated building as simulated by the DEROB system.** Arumi-Noe, F.; Northrup, D. (Univ. of Texas, Austin). 1978.

From Analysis for solar heating and cooling; San Diego, CA, USA (27 Jun 1978).

Hourly thermal perfor.nance data for a passively solar heated house are compared with the simulated data. The house, Solar Village 1, in Santa Fe, New Mexico, owned and occupied by the Douglas Balcomb family, has been instrumented and monitored since the 1976-1977 winter. The data reproduced here were collected in February 1978, including on-site micro-climatic weather data. The simulation is carried out with the computer program DEROB as developed at the Numerical Simulation Laboratory of the School of Architecture of the University of Texas at Austin.

2833 (SAND—78-1927, pp 198-201) **Comparisons of measured and simulated performance for CSU House I.** Mitchell, J.W. (Univ. of Wisconsin, Madison); Beckman, W.A.; Pawelski, M.J. 1978.

From Analysis for solar heating and cooling; San Diego, CA, USA (27 Jun 1978).

The various energy quantities from the simulation are compared to the measured results. The agreement on a daily basis as well as over the entire period is quite good. The useful energy from the collector agrees with that measured within about 5%, which suggests that the assumptions made in the collector component model are acceptable. The heat transferred across the air heater and that delivered by the auxiliary agree within 6%. The energy transferred to the preheat tank agrees within 12% of that measured. These comparisons suggest that the transfer function model developed for the building and the various component models are also satisfactory.

2834 (SAND—78-1927, pp 202-204) **Performance comparisons between FCHART simulations and several operating solar systems.** Gary, W.M. (San Diego Gas and Electric, CA). 1978.

From Analysis for solar heating and cooling; San Diego, CA, USA (27 Jun 1978).

This paper discusses thermal performance and how it compares to an FCHART simulation. The Beckstrand house uses a gas back-up and is located in Del Mar, California approximately three blocks from the Ocean. The other house uses an electric back-up and is located in Jamul, California, which is approximately 25 miles inland. The different system configurations combined with the variation of microclimates provides a good basis for comparison to FCHART computer simulations.

2835 (SAND—78-1927, pp 206-208) **SEEC III: solar heating system optimization program for handheld calculators.** Barley, C.D. (Solar Environmental Engineering Co., Inc., Fort Collins, CO). 1978.

From Analysis for solar heating and cooling; San Diego, CA, USA (27 Jun 1978).

2836 (SAND—78-1927, pp 209-211) **Annual model for solar heating system design and economic evaluation, MESH.** Clark, J.A. (Univ. of Michigan, Ann Arbor). 1978.

From Analysis for solar heating and cooling; San Diego, CA, USA (27 Jun 1978).

2837 (SAND—78-1927, pp 215-218) **New Mexico Department of Agriculture solar heated and cooled building.** Fenton, D.; LaPlante, D.; San Martin, R.L.; Diamond, S.; Packard, C.; Shaw, H.; Stevens, W.; Zwibel, H. (New Mexico State Univ., Las Cruces). 1978.

From Analysis for solar heating and cooling; San Diego, CA, USA (27 Jun 1978).

The New Mexico Department of Agriculture building has been continually operating since September 1975. Space heating and cooling plus domestic hot water are provided by an integrated system utilizing flat plate collectors with an effective area of 5,400 ft² (500²) for the 25,600 ft² (230m²) area building. Performance data collected during 1977 indicates that the solar system provided the entire heat load while the solar fractional contribution for the cooling load was 25 percent. The annual fraction provided by solar energy was 55 percent.

2838 (SAND—78-1927, pp 222-223) **University of Pennsylvania solar heating simulation program: SOLSYS.** Lior, N.; O'Leary, J.; Edelman, D. (Univ. of Pennsylvania, Philadelphia). 1978.

From Analysis for solar heating and cooling; San Diego, CA, USA (27 Jun 1978).

2839 (SAND—78-1927, pp 224-226) **Simulation of a solar-assisted heat pump system with fan coil convectors and evaporative cooling.** Lumsdaine, E.; Cherng, J. (New Mexico State Univ., Las Cruces). 1978.

From Analysis for solar heating and cooling; San Diego, CA, USA (27 Jun 1978).

2840 (SAND—78-1927, pp 227-230) **Extended abstract: a nomograph for solar system seasonal performance.** Newell, T.A.; Swanson, S.R.; Boehm, R.F. (Univ. of Utah, Salt Lake City). 1978.

From Analysis for solar heating and cooling; San Diego, CA, USA (27 Jun 1978).

2841 (SERI/TP—69-412) **Communication strategy to commercialize passive solar energy.** Wolcott, D.R.; Shoemaker, F.F. (Solar Energy Research Inst., Golden, CO (USA); International Business Services, Inc., Washington, DC (USA)). 1979. Contract EG-77-C-01-4042. 6p. (CONF-791022—10). Dep. NTIS, PC A02/MF A01.

From 4. national passive solar energy conference; Kansas City, KS, USA (3 Oct 1979).

Although certain technical and economic issues remain to be clarified, passive solar market development is increasingly dependent upon communications such as information dissemination, education, training and promotional activities. Target audiences are identified as both recipients and disseminators of passive solar communications. Form and quality of information are discussed in terms of the stages of an innovation adoption decision-making process. Several communication-related barriers which impede the commercialization of passive solar are discussed and general information and education responses are suggested. The paper ends with a statement of precepts which should guide passive solar communication programs.

2842 (SOLAR/0022—79/39) **Project monitor: executive summary; introduction; and summary and recommendations. Final report.** Weston, M.W. (International Business Machines Corp., Huntsville, AL (USA)). Jul 1979. Contract EG-77-C-01-4049. 86p. (CONF-790758—1). Dep. NTIS, PC A05/MF A01.

From DOE regional solar update conference; Dearborn, MI, USA (11 Jul 1979).

Results derived from analysis of passive solar space heating systems in the National Solar Data Network are presented. Results are presented which describe the performance of these solar energy systems relative to the facets of design, control, and occupant interactions which provide for good system performance. Performance of passive solar space heating systems is illustrated in terms of system energy savings and thermal comfort conditions.

2843 (UCRL—15001) **Methodology for evaluating physical constraints on residential solar energy use.** Smith, P.L.; McCreary, S.T. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). 1979. Contract W-7405-ENG-48. 73p. Dep. NTIS, PC A04/MF A01.

An attempt is made to bridge the gap between policy planning and implementation at the site level. A procedure is set forth for assessing physical constraints on solar energy use at the site scale and for computerized findings as a data base for analysis at the community, sub-community, and individual parcel scales. Background information regarding the development of the project is presented. Next, the solar technologies being considered, their requirements for optimal performance, and physical constraints on the achievement of those requirements are described. This theoretical discussion is followed by a description of its application to a case study community. A discussion of the types of analyses in which the computerized data can be used is followed by a discussion of the way in which these analyses can be used at various points in governmental and private planning and decision-making processes. (MHR)

2844 **Solar control products.** Murphy, C.H. (to ITD Industries Inc.). US Patent 4,157,417. 5 Jun 1979. Filed date 16 Aug 1978. 8p.

Transparent-reflective metallized solar control compositions and films for application to window glass to reduce heat, glare, etc., of solar radiation are disclosed.

2845 **Solar air systems: the need for equity.** Washington, DC; Ruttenberg, Friedman, Kilgallon, Gutchess and Associates, Inc. (1978). 31p. (NP—24123). The Publisher, Washington, DC.

Report to the Sheet Metal Workers' International Association, October 20, 1978.

Citing the important role of solar energy in meeting our space heating and hot water needs both now and in the years to come, this report calls for an expanded federal solar effort. Specifically, the report calls on the government to provide money to develop and demonstrate one or more solar systems which combine low fabrication and maintenance costs with high efficiency and reliability. The report claims to document the government's failure to put research and demonstration money into solar air systems despite their advantages over liquid systems. These advantages include lower cost, higher heating efficiency, and greater compatability with the most prevalent conventional heating systems. Water systems have received nearly two-thirds of all federal research and development grants and 86 percent of demonstration grants. While finding historical reasons for the tilt toward liquid systems, the report recommends an immediate reversal of the policies which have pushed air systems to the background.

AGRICULTURAL AND INDUSTRIAL PROCESS HEAT

REFER ALSO TO CITATION(S) 2825, 2873

2846 (MTR—7674(Vol.2)) **Solar energy technology transfer source book. Volume II. Solar energy technology delivery systems: agricultural process heat applications.** Hewett, R.; Ellis, D.; Gadsby, G.N.; Spewak, P.; Walker, B. (Mitre Corp., McLean, VA (USA). METREK Div.). Aug 1978. Contract EG-77-C-01-4041. 930p. Dep. NTIS, PC A99/MF A01.

This Source Book is designed to serve as an aid to the planning and management of solar information outreach programs. It also provides a convenient source of related information - primarily at the national level but also at regional, state and local levels. It lists the participants in each of the markets considered, identifies the primary decision makers together with their interactions and decision-making processes. It characterizes the ongoing concerns of such decision makers and details their consequent information needs, together with preferred information mechanisms for reaching each group and their major professional and trade associations. This volume addresses agricultural process heat markets.

2847 (SAND—78-1927, pp 53-55) **Overview of industrial process heat applications.** Anand, D.K.; Allen, R.W.; Burch, G.J. (Univ. of Maryland, College Park). 1978.

From Analysis for solar heating and cooling; San Diego, CA, USA (27 Jun 1978).

The design of eleven industrial process heat projects is reviewed with special emphasis on the thermal performance. It is pointed out that no general purpose program or methodology exists for analysis or performance prediction of industrial process heat systems. Also, the present review identifies important considerations in system design and modeling for industrial process heat applications.

2848 (SAND—78-1927, pp 59-61) **Evaluation of incentive options for commercialization of solar industrial process heating.** Fallah, M.H.; Ciliano, R. (Mathtech, Inc., Princeton, NJ). 1978.

From Analysis for solar heating and cooling; San Diego, CA, USA (27 Jun 1978).

The Energy Conservation and Production Act of 1976 (Public Law 94-385), mandated development of policies, plans, implementation strategies, and program definitions to promote accelerated utilization and wide spread commercialization of solar energy. This study has been sponsored by the Department of Energy to provide a quantitative basis for the development of a commercialization plan to accelerate the implementation of solar technologies to supply industrial process energy needs.

2849 (SERI/TP—34-325) **End-use matching of solar energy systems.** Kreith, F.; Kearney, D.; Bejan, A. (Solar Energy Research Inst., Golden, CO (USA); Colorado Univ., Boulder (USA). Dept. of Mechanical Engineering). 1979. Contract EG-77-C-01-4042. 25p. Dep. NTIS, PC A02/MF A01.

The choice among available energy sources for a given task requires technical and economic tradeoffs on the part of the individual investor. From the national perspective, however, the effectiveness with which available energy sources are utilized may well become an overriding consideration. End-use matching is a procedure for introducing solar energy into the national energy infrastructure. The result of end-use matching is an identification of the most cost-effective combination of process energy needs, solar collector technology, geographic location, and economics by matching currently available solar system hardware with particular industrial processes and their locations. End-use matching is not intended to be a design tool for a specific plant, but rather a planning tool for determining where and for what general applications solar systems appear economically viable in the near- to immediate-term. This paper discusses the end-use matching methodology and illustrates first and second law thermodynamics analyses applied to a solar system producing process steam.

WATER HEATING

REFER ALSO TO CITATION(S) 2732, 2793, 2828, 2837

2850 (SAND—78-1927, pp 167-170) **Survey of solar domestic hot water calculation methods.** Cassel, D.E. (Mueller Associates, Inc., Baltimore, MD); Hedden, R.E.; Glennie, W.L. 1978.

From Analysis for solar heating and cooling; San Diego, CA, USA (27 Jun 1978).

This survey is intended to provide designers with a basis to choose among available methods for sizing residential solar domestic hot water (dhw) systems. Nine methods - six hand methods and three computer programs - are compared regarding theoretical approach, cost of use, time required, ease of use, and other characteristics. The results is a useful guide for the owner/builder as well as the design professional.

2851 (SAND—78-1927, pp 212-214) **Impact of system reliability on savings for solar hot water systems in New England.** D'Aquanni, R.T. (DSD Associates, North Conway, NH). 1978.

From Analysis for solar heating and cooling; San Diego, CA, USA (27 Jun 1978).

2852 (SAND—78-1927, pp 234-236) **Modeling of a solar domestic water system.** Yuill, G.K.; Bradley, B.C. (UNIES Ltd., Manitoba, Winnipeg). 1978.

From Analysis for solar heating and cooling; San Diego, CA, USA (27 Jun 1978).

2853 **Water heater.** Gaskill, E.P. US Patent 4,157,706. 12 Jun 1979. Filed date 28 Apr 1978. 6p.

A water heater cacable of utilizing as one of its heat sources hot exhaust gases emitted from at least one other heat source such as a furnace fueled by a natural resource fuel such as gas or oil, and capable of utilizing as another of its heat sources heat emitted from a fluid heated by solar energy. The water heater comprises a central flue having a heat conductive wall, one end of the said flue having a thimble member secureable to an exhaust pipe carrying hot exhaust gases from a heat source fueled by a natural resource fuel, and the other end of said flue secureable to a chimney leading to the atmosphere. Disposed within the flue is a turbulator means which disperses entering hot exhaust gases along the surface of the flue wall. A fluid tight tank for water surrounds the central flue, said tank having as its inner wall the wall common to the flue and having a heat conductive outer wall, and having an inlet pipe at the bottom of the tank for entrance of water under pressure and an outlet pipe at the top for exit of water under pressure. Disposed within the tank is a turbulator means which disperses entering water along the interior surfaces of the inner and outer tank walls. Surrounding and in contact with the outer wall of the tank is a hollow jacket to house fluid which is to be in communication with like fluid within a solar heat collection means, with the walls of said jacketbeing heat conductive. Said fluid is made to circulate between the jacket and the solar heat collection means by means of a circulator which is activated thermostatically only above selected temperatures of the fluid situated within the solar heat collection means, the water to be heated, and the gases within the flue. Finally, insulation means which inhibits heat conduction surrounds the jacket.

OTHER

2854 (SAN—1894/1) **Solar powered liquid piston Stirling cycle irrigation pump. Research grant, May 1, 1978-December 31, 1978.** Bell, G.C. (New Mexico Univ., Albuquerque (USA). Center for Environmental Research and Development). 10 Apr 1979. Contract ET-78-G-03-1894. 29p. Dep. NTIS, PC A03/MF A01.

Project objectives and work performed during the duration of the grant included construction of a laboratory prototype of the liquid piston Stirling cycle heat engine with modeling and simulation, a range of engine sizes to determine lift head ranges, capacities and principles of operation. Preliminary investigation of solar energy inputs indicates numerous feasible methods to operate heat engines. The maximum rate of pumping obtained was one liter per 26 seconds through 109 cm lift head.

2855 **Apparatus for solar distillation.** Bellande, R.H.; Wilson, D.C. (to Avant, Ltd.). US Patent 4,159,228. 26 Jun 1979. Filed date 11 Oct 1977. 4p.

An apparatus is disclosed for the solar distillation of contaminated water which includes a substantially airtight enclosure having an evaporation chamber and condensation chamber. The evaporation chamber has a lower reservoir and an upper inclined surface which is transparent to solar radiation. The condensation chamber includes a thermally conductive condensation wall and a collecting reservoir for collecting the condensed water. A thermal insulative partition is located intermediate the evaporation chamber and the condensation chamber, and includes an upper port and a lower port. At least one thermally conductive conduit may be located within the condensation chamber and externally vented at the upper and lower portions thereof.

SOLAR COLLECTORS AND CONCENTRATORS

REFER ALSO TO CITATION(S) 2719, 2760, 2766, 2792

2856 **Solar collector comprising solar tracking means.** Prast, G. (to Philips Corp.). US Patent 4,159,710. 3 Jul 1979. Priority date 20 Sep 1976, Netherlands, 6p.

A solar collector includes a plurality of elonage parallel reflectors mounted for rotation about their respective longitudinal axes, together with mechanism coupled to the reflectors for simultaneously rotating the same. An elongate absorber is arranged parallel to the reflectors for collecting solar radiation focussed thereon by the reflectors. Tracking means including two solar sensor reservoirs containing a vaporizable/condensible liquid working medium is provided for rotation of the reflectors to control the focussing of solar radiation on the absorber.

2857 (COO—2597-5) **Methods for reducing heat losses from flat plate solar collectors: Phase III. Final report, May 1, 1977-January 31, 1979.** Hollands, K.G.T.; Raithby, G.D.; Russell, F.B.; Wilkinson, R.G.;. (Waterloo Univ., Ontario (Canada)). Mar 1979. Contract EY-76-G-02-2597. 88p. Dep. NTIS, PC A05/MF A01.

The present study extends earlier studies by examining the effect of the emissivities of both the absorber plate and the glass cover on the honeycomb's ability to suppress free convection, and on the radiative and conductive heat transfer which takes place across the honeycomb in the absence of free convection. By means of heat transfer measurements on ten Mylar honeycombs, this study has shown that the effect of the above emissivities on the suppression of convection by the honeycomb is slight, and can probably be ignored. On the other hand, the measurements also showed that the effect of these emissivities on the non-convective heat transfer is substantial, but not nearly so large as would have been predicted by existing theories. To explain this latter result theories were developed which take into account the important coupling (ignored by previous theories) between the conductive and radiative modes of heat transfer. These new theories predict the measured heat transfer rates to with about +-15%, depending on the emissivities. The results of this study have direct application to evaluating solar collectors which combine a selective surface with a honeycomb.

2858 (COO—2971-6) **Interferometric study of the natural convection characteristics of flat plate, slat and vee-corrugated solar collectors. Final report.** El Wakil, M.M.; Mitchell, J.W. (Wisconsin Univ., Madison (USA)). 30 Jun 1979. Contract EY-76-S-02-2971. 7p. Dep. NTIS, PC A02/MF A01.

The natural convection heat transfer relations for the heat transfer between absorber and cover plates of solar collectors have been studied. Interferometric techniques were employed to evaluate the local coefficients. Average values were obtained by integration of the local values. The results are presented in terms of correlations between Nusselt number and Grashof number. The investigations were carried out over tilt angles of 45 to 90 degrees. The Grashof number range tested was representative of that existing in flat plate collectors. The various geometrics included large flat enclosures, small aspect ratio enclosures representative of honeycomb or slat collectors, vee-corrugated (vee-grooved) collectors, and compound parabolic concentrators.

2859 (SAND—78-1927, pp 40-42) **Development and application of SOCOSIM, a TRNSYS-compatible simulation program for flatplate and concentrating solar collectors: a study of longterm performance of parabolic trough concentrators.** Whale, R.D.; Clark, E.E. (Trinity Univ., San Antonio, TX). 1978.

From Analysis for solar heating and cooling; San Diego, CA, USA (27 Jun 1978).

SOCOSIM is a solar collector simulation program developed at Trinity University which predicts the performance of not only flatplate but also a variety of other collectors. SOCOSIM has the capability of simulating the performance of: (1) a flatplate collector; (2) a NS axis tracking concentrator of any tilt; (3) an EW horizontal axis tracking concentrator; (4) a two-axis tracking concentrator; (5) a stationary south-facing evacuated tube collector with NS absorber axis; (6) a stationary south-facing compound parabolic concentrator (CPC) with EW absorber axis.

2860 (SAND—78-1927, pp 46-48) **Computer simulation of solar system design in Alberta with particular reference to open channel flow and plastic covers.** Smith, G.E. (Univ. of Calgary, Alberta). 1978.

From Analysis for solar heating and cooling; San Diego, CA, USA (27 Jun 1978).

The model simulates both the closed tube liquid collector and the open channel flow collector, either singly or doubly glazed. It has been used for a number of simulations for Edmonton, Alberta presented in Smith (1977).

2861 (SAND—78-1927, pp 74-77) **Photographic/analytical technique for estimating the impact of shade on the performance of solar domestic hot water systems.** Brooks, W.W.; Guckes, T.L. (Exxon Enterprises Inc., Florham Park, NJ). 1978.

From Analysis for solar heating and cooling; San Diego, CA, USA (27 Jun 1978).

This paper presents the results of a study aimed at quantifying the impact of shade on the performance of residential solar domestic hot water systems. Both the details of the analysis procedure and the results from applying this procedure will be discussed.

2862 (SAND—78-1927, pp 100-102) **Stagnation simulation under transient solar conditions.** Dame, R.E.; Dalton, J. (Mega Engineering, Silver Spring, MD). 1978.

From Analysis for solar heating and cooling; San Diego, CA, USA (27 Jun 1978).

A transient analysis of a flat plate collector system under no flow condition was developed using TEMPS program. The results of this program are compared with test data as well as results produced using the TRNSYS computer program, developed by the University of Wisconsin. A review of the comparisons indicates that difficulties may be encountered when using some transient simulation routines for predicting stagnation performance of flat plate collectors.

2863 (SAND—78-1927, pp 137-138) **High performance flat plate solar collector.** Lansing, F.L.; Clarke, V. (Jet Propulsion Lab., Pasadena, CA). 1978.

From Analysis for solar heating and cooling; San Diego, CA, USA (27 Jun 1978).

Various configurations of flat plate solar air heaters with porous matrices are presented. An example air heater is described. Vacuum between glazing sheets and/or selective coating of porous matrix surface can be employed to reduce thermal losses. The collector was selected for the one dimensional steady state thermal analysis. The basic assumptions include: (1) uniform thermal, physical and transport properties, (2) equal temperatures for the flowing air and the matrix pores at any position and (3) convection and radiation losses are only from the top surface of the matrix facing the sun. The temperature distribution was determined by solving the heat transfer rate equations of a collector segment, and setting the boundary conditions.

2864 (SAND—78-1927, pp 219-221) **Comparison of solar thermal energy collection using fixed and tracking collectors.** Garrison, J.D.; Craig, G.T.; Morgan, C. (San Diego State Univ., CA). 1978.

From Analysis for solar heating and cooling; San Diego, CA, USA (27 Jun 1978).

2865 (SAND—78-1927, pp 231-233) **Extended abstract: optimization of manifolding for large solar collector arrays.** Shadis, W.J. 1978.

From Analysis for solar heating and cooling; San Diego, CA, USA (27 Jun 1978).

This paper describes a method of determining the minimum acceptable manifold size for a solar collector array based upon the principle of maximized system present value.

2866 (SAND—79-7014) **Design and fabrication of prototype combined photovoltaic/thermal non-tracking collector.** Jandorf, H.; Flourshetz, L.; Schwartz, F.M. (Spectrolab, Inc., Sylmar, CA (USA)). Jun 1979. Contract EY-76-C-04-0789. 56p. Dep. NTIS, PC A04/MF A01.

Work performed to design, fabricate, test and analyze future production costs of a combined photovoltaic/thermal collector is summarized. Design improvement recommendations and future applications of the combined collector are considered.

2867 (SERI/TR—34-083) **Survey of solar thermal test facilities.** Masterson, K. (Solar Energy Research Inst., Golden, CO (USA)). Aug 1979. Contract EG-77-C-01-4042. 127p. Dep. NTIS, PC A07/MF A01.

The facilities that are presently available for testing solar thermal energy collection and conversion systems are briefly de-

scribed. Facilities that are known to meet ASHRAE standard 93-77 for testing flat-plate collectors are listed. The DOE programs and test needs for distributed concentrating collectors are identified. Existing and planned facilities that meet these needs are described and continued support for most of them is recommended. The needs and facilities that are suitable for testing components of central receiver systems, several of which are located overseas, are identified. The central contact point for obtaining additional details and test procedures for these facilities is the Solar Thermal Test Facilities Users' Association in Albuquerque, N.M. The appendices contain data sheets and tables which give additional details on the technical capabilities of each facility. Also included is the 1975 Aerospace Corporation report on test facilities that is frequently referenced in the present work.

2868 Scope of effective medium theory for fine metal particle solar absorbers. Smith, G.B. (Physics Department, University of Houston, Houston, Texas 77004). *Appl. Phys. Lett.;* **35**: No. 9, 668-670(1 Nov 1979).

The treatment of an array of small metal particles as a continuous effective medium is shown to be possible for visible and near infrared frequencies at much larger particle sizes and separations than often supposed. Specific upper limits are evaluated for chromium. Results are based on the strongly correlated model. For this, the usual topology, variation, and attenuation of the field strength over average unit cell dimensions are permissible, provided such variations are characteristic of the effective medium as a whole. As wavelength decreases, the leading contribution to diffuse scattering off such composite films should come from terms proportional to λ^{-8} not the Rayleigh term.

2869 Solar heat collector. Barker, R.D. US Patent 4,170,222. 9 Oct 1979. Filed date 19 Aug 1977. 4p.

A solar heat collector constructed from transparent material utilizes a circulating absorptive fluid medium to collect solar energy. The collector comprises a plurality of cascaded fluid reservoirs, each reservoir having a self-draining feature active during a stagnant condition.

2870 Solar heat collector. Smith, H.C. US Patent 4,170,220. 9 Oct 1979. Filed date 2 Jun 1978. 4p.

A solar heat collector is illustrated wherein a flat box has an inlet port and an outlet port connected by a tortuous flow path defined by upright baffle means, said tortuous flow path including a plurality of individual side-by-side interconnected passageways.

2871 Solar heat collector construction. Gavin, J.G. (to Grumman Corp.). US Patent 4,170,221. 9 Oct 1979. Filed date 16 Jan 1978. 2p.

A solar heat collector is disclosed having an array of liquid transporting tubes and a plurality of heat absorber panels joined by a tube gripping accommodation on each panel providing structural integrity and good thermal conductivity.

2872 Solar heat energy collector. Weideman, A.C. US Patent 4,170,223. 9 Oct 1979. Filed date 21 Jun 1977. 8p.

The invention provides a solar heat energy collector, more particularly of the kind used for heating water which comprises two members, for instance, metal sheets, between which is sandwiched sealing means located towards the periphery of the members to provide a receptacle. The two members are held in sealing contact with the sealing means by means of clamping means which is forced over peripheral portions of the two members. Provision is made for restricting movement of the sealing means between the plates and against dislodgement of the clamping means.

2873 Solar converter. Ehrlich, B.H. US Patent 4,169,459. 2 Oct 1979. Filed date 17 Jun 1977. 10p.

A solar heating unit is disclosed which is covered at the top by a glass plate and at the bottom by an insulating layer, and at a height therebetween by an absorber plate which divides the unit into an upper and lower chamber through which forced air is guided to flow in opposite directions in contact first with the top and then the bottom surface of the absorber plate. The absorber plate has a smaller spacing from the glass cover than from the bottom insulating layer so that the air flows through the upper chamber at a faster rate than through the lower chamber. Due to this design the temperature gradient of the air on the two sides of the cover plate is held relatively low and heat losses through this cover are reduced at a minimum of expense. Several portable heating units of this design may be serially connected to form a free-standing solar heating assembly, for example, for supplying drying air to a grain bin.

2874 Phenolic laminate solar absorber panel and method of making. Severson, A.M. (to Honeywell Inc.). US Patent 4,167,935. 18 Sep 1979. Filed date 26 Sep 1977. 6p.

A solar flat plate absorber panel is molded from a laminate consisting of a suitable web material impregnated with a thermosetting phenolic resin. The absorber plate is pressure formed from superimposed layers of material and mold-cured to produce a unitary structure having a first or solar radiation absorbing surface on one side and an integral closed hollow lattice work of fluid heat transfer passages on the other or reverse side of the panel. The laminate web may be made from any suitable material such as paper, cloth, canvas, or wire mesh which is easily impregnated with a thermosetting phenolic resin. In the preferred embodiment a B-stage phenol-formaldehyde resin is used. The two superimposed sheets of impregnated material are molded between heated platens of an hydraulic press to form an integral structure and fluid pressure between the sheets is utilized to mold the desired passage shape 5.

2875 Stationary type solar energy collector apparatus. Brussels, N.E. (to Solar Energy Systems, Inc.). US Patent 4,167,178. 11 Sep 1979. Filed date 27 Jun 1977. 12p.

A hybrid collector for collecting solar energy is disclosed comprised of a plurality of parabolic reflectors cooperating with tube/fin type fluid carrying collector elements, selective ones of which are arranged at the focal points of the parabolas. Additional tube/fin elements are positioned at a spaced distance above the boundary line between adjacent parabolic reflectors. The exterior surfaces of the tube/fin collector elements are treated preferably with a selective coating to provide high absorptivity and low emissivity. The surface areas of the tube/fin elements are also reduced to further contribute to a reduction in emissivity to optimize total absorptance. Location of the tube/fin elements which are off the parabolic reflector focal points cooperate with those located at the focal points to absorb diffuse energy while the tube/fin elements at the focal points absorb beam energy providing for both absorption of beam energy on clear sunny days and absorption of diffuse energy on cloudy or overcast days. The positioning of the tube/fin collectors well above the reflectors takes advantage of convection currents to increase energy transfer by reduction of energy loss. The structure provides the above functions through a fully stationary mounting. The parabolic reflector structures comprise flexible reflector sheets mounted within supporting troughs which are adapted to slideably receive the reflective sheets and urge the sheets into perfect parabolic configurations due to the geometry and interrelationship of the troughs and the reflective sheets, yielding a perfect parabolic reflector produced in an inexpensive manner.

2876 Solar heat apparatus. Dukess, J. US Patent 4,166,769. 4 Sep 1979. Filed date 6 May 1977. 4p.

A solar energy device is disclosed comprising a body having a plurality of spaced focusing lenses to concentrate direct and reflected rays from the sum. A heat receiving member is inside of said body. One of the body and the member is expansible and contractible so as to direct the member into exact convergence with the focal points of said lenses. The member is supported within said body and fed fluid to be heated. The heated fluid is then removed from the member. The heat receiving member that is expansible and contractible may be employed separately and used as a prime mover.

2877 Solar collector. Youngs, J.A. (to BBC Brown Boveri and Co.). US Patent 4,166,446. 4 Sep 1979. Priority date 3 Dec 1976, Switzerland, 4p.

A solar collector is disclosed comprising liquid-containing elements and a reflector. The reflector comprises overlapping plates which can be shifted into a first extended position imparting an approximately semicylindrical shape to the reflector and into a second collapsible position. The liquid-containing elements comprise a collector pipe or conduit enclosed by a protective tube. Radial elements extend in the longitudinal direction of the collector pipe and are attached thereto. The liquid-containing elements are rotatably mounted on the collector pipe.

2878 Solar energy collector system. Middleton, V.L.; Kleine, C.A. (to Olin Corporation). US Patent 4,165,733. 28 Aug 1979. Filed date 31 Mar 1977. 8p.

An improved solar energy collector system is described which permits the inexpensive incorporation of various temperature sensing and control means. The system includes at least one heat exchanger panel possessing a system of internal tubular passageways. The improvement in the present design comprises the provision of at least one internal second passageway in the heat exchanger panel adjacent to the internal tubular passageways but spaced and independent therefrom.

2879 Solar energy collector and storage device. Smith, H.T. US Patent 4,165,735. 28 Aug 1979. Filed date 25 Oct 1977. 4p.

An improved flat plate solar energy collector of integral construction capable of mass production in which metal tubing is eliminated is described. The collector includes a stamped planar tray and a radiant energy absorber plate connected together to form the inlet and outlet fluid header and the innerconnecting channels therebetween. The planar tray and absorber plate are mounted in a molded insulated housing which integrally includes a storage tank. A fluid medium such as water is heated by solar radiation and circulated through the collector to the storage tank by thermal syphon.

Elimination of conventional tubing greatly reduces fabrication costs and increases absorption efficiency.

2880 **Solar energy collector and heat exchanger.** Pyle, D.L. (to Near Star Solar, Inc.). US Patent 4,159,708. 3 Jul 1979. Filed date 17 Jun 1977. 10p.

A solar energy collector and heat exchanger for use in a solar energy system that provides space heating and preheating of water for a building or residence is disclosed. The solar collector and heat exchanger comprises a rectangularly shaped, box-like housing. A thermal pane glass panel covers the top of the housing and permits radiant energy to pass therethrough to the interior of the housing. An arrangement of transversely extending baffles are placed in the lower portion of the housing to define an uncovered serpentine channel running longitudinally through the housing. An air inlet port and an air outlet port are provided in the bottom of the housing to direct air into and out of the channel defined by the baffles. A metallic sheet covers the channel and has airflow connections therethrough leading from the air inlet and air outlet ports to the upper portion of the housing. A fluid system including a planar array of tubing having a number of longitudinal runs that extend parallel to the sides of the housing is provided, with adjacent tubes being interconnected to form a single conduit having an inlet and an outlet extending out of the housing. Additional baffles are provided in the upper portion of the housing to define a serpentine channel therein that overlays the lower channel and communicates with the air inlet and air outlet ports through the airflow connections. The thermal pane glass panel covering the top of the housing defines the ceiling for the upper channel. Curved upper and lower airflow guides are positioned between adjacent baffles in both the lower and upper channels to facilitate a smooth flow of air through each.

2881 **Solar collector comprising an evacuated absorber cover tube.** Mahdjuri, F. (to Philips Corp.). US Patent 4,159,706. 3 Jul 1979. Priority date 23 Mar 1976, German, Federal Republic of (F.R. Germany), 4p.

A solar collector is disclosed comprising an evacuated, transparent cover tube sealed at its ends and an associated selective absorber, the inner surface of at least one end of the cover tube being provided with a metallic reflective layer.

2882 **Low cost solar panel.** Palazzetti, M. (to Fiat Societa per Azioni). US Patent 4,159,709. 3 Jul 1979. Priority date 20 Jul 1976, Italy, 4p.

A low-cost solar panel is fabricated from three laminated plastics layers, the upper two layers being transparent to luminous and infra-red solar radiation and the bottom layer being opaque; in one version water to be heated flows first between the upper two layers and then between the lower two layers to be further heated in flowing over the bottom layer.

2883 **Solar panel system.** Novi, S. US Patent 4,159,017. 26 Jun 1979. Filed date 16 Jan 1978. 6p.

A solar heating panel has a rectangular frame to receive a rectangular metal pan which supports a continuous coil of water tubing which is attached thereto by strips of metal attached to the pan. Preferably, the frame is divided into quadrants by rails. Each quadrant is closed off by a pane of glass cushioned and weatherstripped to the frame and rails. Above the glass is a continuous sheet of a synthetic, highly transparent plastic which is attached to the frame by a gasket. Provision is made for thermal expansion of the various components, for drainage, for prevention of leakage of moisture and for insulation. The panel can be incorporated in a household water heating system and also to heat space. The metal pan has a roughened surface (e.g., pebbled, diamond-embossed) and is painted black. This structure increases the area exposed to the sun, eliminates reflection, interrupts flow of cooling air across the surface of the pan, and reduces the effect of expansion and contraction.

2884 **Solar radiation collector.** Heller, R.; Kuehne, P. (to Contraves AG). US Patent 4,155,347. 22 May 1979. Filed date 24 Feb 1978. 6p.

A solar radiation collector is disclosed for generating useful heat in a liquid, comprising an essentially horizontal liquid infeed line and a liquid outfeed line. A heating device for heating the liquid incorporates radiation absorbing, mutually spaced tubes interconnecting the infeed line with the outfeed line, the lengthwise axes of the tubes each coinciding with a focusing axis of an associated mirror or reflector, all of the mirrors being rotatable about their focusing axis in order to focus the incident solar radiation upon the associated tube. The heating device is mounted as a unit in a completely closed hollow compartment. The infeed and outfeed lines are embedded as supporting reinforcement means in the longitudinal walls of the hollow compartment, and these longitudinal walls in conjunction with the transverse walls interconnecting such longitudinal walls form a self-supporting frame construction for the front window and the rear closure wall of the hollow compartment which contains the heating device.

HEAT STORAGE

REFER ALSO TO CITATION(S) 2795, 3098, 3102, 3124

2885 (BNL—51012) **Review of recent research on energy storage in residential solar total energy systems.** Leigh, R.W. (Brookhaven National Lab., Upton, NY (USA)). May 1979. Contract EY-76-C-02-0016. 15p. Dep. NTIS, PC A02/MF A01.

Current and recent research relevant to residential applications of solar total energy are reviewed. For each project or study, the types of energy storage devices chosen and the methods used to integrate them with solar collectors and backup devices are emphasized. Several general conclusions are distilled from the studies to guide subsequent research.

2886 (CONF-781231—, pp 51-54) **Thermal energy storage subsystem for solar heating and cooling applications (Rolling Cylinder Thermal Storage System).** Herrick, C.S.; Thornton, R.F. (General Electric Corporate Research and Development, Schenectady, NY). 1979.

From 3. annual thermal energy storage contractor's information exchange meeting; Springfield, VA, USA (5 Dec 1978).

The overall objective of this program is to develop the technology and the engineering data required to implement rolling cylinder thermal energy storage in solar energy systems. The purpose of this contract is to design, and build a large, approximately 200,000 Btu prototype in an instrumented calorimeter. During the first year of the contract, the thermal characteristics of the system will be carefully defined and designs will be developed for the prototype rolling cylinder device and for its associated test equipment. During the second year of the contract, the prototype and test equipment will be constructed and preliminary checkout accomplished. A follow-on contract will be proposed the third year during which the prototype will be tested for its performance characteristics. The rolling cylinder thermal energy storage concept is described, and status of the project is summarized.

2887 (CONF-781231—, pp 191-196) **High temperature underground storage of solar energy.** Collins, R.E. (Univ. of Houston, TX). 1979.

From 3. annual thermal energy storage contractor's information exchange meeting; Springfield, VA, USA (5 Dec 1978).

The development of an efficient method for storage of large quantities of heat for use during future demand periods could provide a significant impact on the utilization of energy sources. Underground storage of sensible heat by hot fluid injection for subsequent electric power production is under investigation in this study. The basic requirement is to be able to inject and store large volumes of fluid heated to a high temperature because large scale systems have lower relative thermal losses and high storage temperatures yield more efficient electric power production. The two storage systems under study are deep aquifer storage of high temperature, high pressure water and cavern storage of hot oil within solution caverns in massive salt deposits. Aquifer storage efficiency is reduced because downhole pumping is required for recovery. Also silica solubility and deposition present a major problem at the temperatures considered. For near term application hot oil storage in a gravel filled salt cavern with a nitrogen gas cap appears most feasible. The project status is reported.

2888 (CONF-781231—, pp 217-225) **Development of a phase-change thermal storage system using modified anhydrous sodium hydroxide for solar electric power generation.** Cohen, B.M. (Comstock and Wescott, Inc., Cambridge, MA). 1979.

From 3. annual thermal energy storage contractor's information exchange meeting; Springfield, VA, USA (5 Dec 1978).

In the generation of electric power from solar heat by means of a heat engine, storage of heat is necessary in order to make the power generation system independent of the solar insolation. The heat storage element of such a system is one of the more costly elements, and the cost goals for thermal storage have not yet been achieved. One approach to thermal storage for solar-electric systems which offers a possibility for reducing the cost of storage is the use of thermal storage media which undergo phase changes between solid and liquid states or between two solid states within the operating temperature range, making the latent heats of the phase changes as well as sensible heat available for heat storage and retrieval. Thi project has comprised an analytical and experimental study of the physical and operating characteristics of a phase change thermal storage system suitable for use in a solar total energy system whose solar collectors operate in the mid-temperature range, and estimation of its manufacturing cost. The project status is described.

2889 (CONF-781231—, pp 357-365) **Chemical energy storage for solar thermal conversion.** Smith, R.D. (Rocket Research Co., Redmond, WA). 1979.

From 3. annual thermal energy storage contractor's information exchange meeting; Springfield, VA, USA (5 Dec 1978).

The project's goal is the evaluation from a total system point-of-view of the concept of thermal energy storage by reversible chemical reaction for Solar Thermal Electric Conversion (STEC) applications. The purpose of this study is: (1) to identify potential chemical reactions capable of operating at one of three nominal temperatures (588, 783, or 1310°K), and to tabulate their physical, thermochemical, and kinetic properties; (2) to conceptually design storage subsystems for specified solar thermal electric power plants for selected reactions; and (3) to establish the technical and economic feasibility of using thermal energy storage subsystems to extend solar thermal electric systems to baseload capability. Fourteen attractive systems were identified by the reaction screening. Preliminary estimates of the associated power and energy costs and system performance were made to arrive at this selection. Storage subsystems based upon the reactions have been designed to provide more accurate cost and performance data for use in a computer model of a stand-alone, or grid independent, power plant.

2890 (CONF-781231—, pp 367-374) **Chemical energy storage for solar thermal conversion/extended storage studies.** Iannucci, J.J. (Sandia Labs., Livermore, CA). 1979.

From 3. annual thermal energy storage contractor's information exchange meeting; Springfield, VA, USA (5 Dec 1978).

The project's goal is to assess the economic and performance impact of chemical energy storage on solar thermal electric conversion plants, especially for extended duration storage. A computer model developed performs an hour-by-hour simulation of the solar plant as it attempts to meet a specified demand with available solar insolation, energy from storage, energy from a fossil-fuel backup system, or from some combination of these sources. For a plant required to meet all of the specified load with solar input, the optimization code conducts tradeoffs between collector, receiver, and storage subsystems to arrive at the design which minimizes busbar energy cost. Thus far, three central receiver systems have been simulated with the model: one based upon a Rankine cycle using steam as the working fluid, and the other two based upon open and closed Brayton cycles using air and helium, respectively, as the working fluids. The conclusions drawn from the work performed to date are: (1) large solar contributions are achievable with modest amounts of storage (20 to 50 h, depending on location) since this first part of storage is used frequently, whereas the seasonal storage segment is not, (2) inexpensive storage is much more important in regions with poor insolation characteristics, (3) variations in insolation from year to year can alter significantly the storage requirements and busbar energy costs for 100% solar plants, and (4) a hybrid plant with a fossil fuel backup system is a more economical way to provide the desired electrical load.

2891 (CONF-781231—, pp 385-397) **Solar energy storage by reversible chemical processes.** Springer, T.H. (Rockwell International Corp., Canoga Park, CA). 1979.

From 3. annual thermal energy storage contractor's information exchange meeting; Springfield, VA, USA (5 Dec 1978).

The project's goal is to verify the technical feasibility and economic attractiveness of the $CaO/Ca(OH)_2$ reversible chemical solar energy storage concept. A very substantial amount of information about the $CaO\text{-}Ca(OH)_2$ reaction has been developed to date: the reaction is completely reversible, the rates of reaction are acceptable, the heat of reaction is as expected, and the material can be cycled at least 1000 times without inherent degradation. Thus, although uncertainties remain at this time, inorganic oxide-hydroxide thermal storage appears to be very attractive, especially since the materials are inexpensive. The products of reaction are basically very safe (one of the products is water which is, of course, universally available), the energy density can potentially be very high, the energy can be transported, and the energy can be stored indefinitely. The project status is reported.

2892 (CONF-781231—, pp 399-405) **Chemical storage of thermal energy.** Foss, A.S.; Lynn, S. (Lawrence Berkeley Lab., CA). 1979.

From 3. annual thermal energy storage contractor's information exchange meeting; Springfield, VA, USA (5 Dec 1978).

The project's goals are to develop and evaluate process flowsheets that integrate the operation of a solar steam-cycle power plant and a chemical storage system utilizing the reaction $SO_3 \rightleftharpoons 1/2\ O_2$. A sensible heat storage system using comparable bases will be designed and evaluated as an additional means of determining the potential of chemical energy storage. A technically feasible flowsheet has been developed that maximizes the efficiency of the combined steam-cycle power plant and energy storage system through energy interchange between the two. A computer program has been developed by which the chemical storage system heat and material balances are calculated. Equipment for the storage system flowsheet has been sized and costed. The sensitivity of the efficiency of the system to changing several of the key parameters has been determined. A sensible heat storage system has been designed that uses magnesia brick cycling between 300° and 800°C. The storage system is operated in series with a steam-cycle power plant. A computer program has been developed to simulate the cyclic operation of the storage unit. A base-case flowsheet for the entire process has been sized and costed. In addition, a short-term study of the use of a gas turbine for power production from the $SO_3\text{-}SO_2\text{-}O_2$ system has been initiated.

2893 (SAND—78-1927, pp 33-36) **Design of liquid shell and tube heat exchangers for use in solar systems.** Leflar, J.A.; Hull, D.E. III; Winn, C.B. (Colorado State Univ., Fort Collins). 1978.

From Analysis for solar heating and cooling; San Diego, CA, USA (27 Jun 1978).

Heat exchangers are often required between liquid solar collectors and liquid heat storage. A heat exchanger in this location degrades solar system performance because the fluid temperature at the collector inlet is higher than the fluid temperature entering the heat exchanger from storage. Counterflow shell and tube heat exchangers are well suited to solar systems because of their compact size, high test transfer, and relatively low cost. Single or multiple tube pass heat exchangers are available with the multiple tube pass units usually being applied to situations where small approach temperatures are required. Single and multiple tube pass heat exchangers are analyzed for use with solar collectors based on equivalent design parameters and fluid pumping power requirements. Single tube pass heat exchangers are shown to be the optimal heat exchanger type for use with solar collectors.

2894 (SAND—78-1927, pp 37-39) **Heat transfer in a PCM-filled wall.** Solomon, A.D. (Union Carbide Corp., Oak Ridge, TN). 1978.

From Analysis for solar heating and cooling; San Diego, CA, USA (27 Jun 1978).

Consider a wall composed of bricks or panels which are composites of a PCM (phase change material) in a building-material matrix. The heat flow characteristics of such a wall are studied for a variety of external conditons.

2895 (SAND—78-1927, pp 139-142) **Modeling of a thermal wall panel using phase change materials.** Gueceri, S.I.; Faunce, S.F. (Univ. of Delaware, Newark). 1978.

From Analysis for solar heating and cooling; San Diego, CA, USA (27 Jun 1978).

This work presents a modeling effort for a thermal wall being tested at the University of Delaware, Solar One House under the auspices of the Institute of Energy Conversion. The PCM is contained in small diameter tubes with staggered arrangement. Charging of the unit is done during the periods of insolation using direct solar radiation. The discharge of the unit is provided by air flow across the tube arrangement to carry heat. The computer model is developed to predict the response of the unit during its discharge from a given initial state.

2896 (SAND—78-1927, pp 143-145) **Simulation of stratified heat storage in solar heating systems.** Connor, D.W.; Mueller, R.O. (Argonne National Lab., IL). 1978.

From Analysis for solar heating and cooling; San Diego, CA, USA (27 Jun 1978).

In solar heating systems employing sensible heat storage (SHS), the collector losses tend to increase linearly with the quantity of stored heat, thereby reducing the rate of solar heat delivery to SHS and ultimate load. This tendency can be mitigated to a useful degree if the SHS is stratified, with some additional improvement in the delivery of stored heat to useful load. Two types of stratified SHS are approximately realizable in practice, namely time-ordered (exemplified by the rock bed) and temperature-ordered (buoyancy-ordering in liquid tanks). An extensive analytical treatment is given of solar-thermal systems embodying idealized unstratified or stratified SHS. The work reported here on simulation of such systems relies heavily on the earlier analysis.

GEOTHERMAL ENERGY

2897 (DOE/EV—0046(Vol.3)) **Proceedings of the US Department of Energy environmental control symposium. Volume 3. Solar energy, geothermal energy, and waste heat transmission.** (Department of Energy, Washington, DC (USA). Div. of Environmental Control Technology; Argonne National Lab., IL (USA)). Sep 1979. Contract W-31-109-ENG-38. 501p. (CONF-781109—(Vol.3)). Dep. NTIS, PC A22/MF A01.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

Abstracts were prepared for twenty-one papers, seven were abstracted previously for EDB, and two were listed by title. (MHR)

2898 (SAND—79-0522(Vol.5)(No.1), pp 1-4) **Geo-energy technology program.** Stoller, H.M. May 1979.

In Sandia technology.

The major elements of the Geo-Energy Technology program at Sandia Laboratories and a number of accomplishments to date are described. (MHR)

GEOLOGY, HYDROLOGY, AND GEOTHERMAL SYSTEMS

USA

REFER ALSO TO CITATION(S) 2910

2899 (UCRL—52496(Vol.4)(Rev.1)) **Environmental overview of geothermal development: the Geysers-Calistoga KGRA. Volume 4. Environmental geology.** Crow, N.B. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 9 Oct 1979. Contract W-7405-ENG-48. 77p. Dep. NTIS, PC A05/MF A01.

This report is one of a series of volumes reporting the results of an overview study of environmental issues in The Geysers-Calistoga Known Geothermal Resource Area region in the Northern California Coast Ranges. Part I presents the recommended projects together with supporting discussions of the environmental issues and related geologic information, thus serving as an executive summary. These recommendations are intended as a guide to detailed planning, and are not project work statements. Part II is a review of the published and open-file earth sciences literature about the region. It describes the regional framework of the geology, geophysics, and hydrology and provides information about the geothermal resources and the several kinds of geologic hazards - accelerated erosion including landslides, potential interrelationships between geothermal fluids and both potable and thermal ground water, subsidence, and induced seismicity - that may affect the environment as consequences of geothermal development. Studies should be concentrated in relatively small areas where geothermal development is likely. Some of the projects recommended are listed. The Appendix to this report is a comprehensive bibliography of scientific information about the Clear Lake - The Geysers region.

2900 (USGS-GMS—10) **Low- to intermediate-temperature thermal springs and wells in Oregon.** Bowen, R.G.; Peterson, N.V.; Riccio, J.F. (comps.). (Oregon State Dept. of Geology and Mineral Industries, Portland (USA)). 1978. vp. Oregon Dept. of Geology and Mineral Industries, Portland.

The thermal springs and wells are listed by county with location, temperature, references, and notes of interest. (MHR)

2901 **Thermal springs of Wyoming.** Breckenridge, R.M.; Hinckley, B.S. Laramie, WY; Geological Survey of Wyoming (1978). 112p. (NP—24151).

This bulletin attempts, first, to provide a comprehensive inventory of the thermal springs of Wyoming; second, to explore the geologic and hydrologic factors producing these springs; and, third, to analyze the springs collectively as an indicator of the geothermal resources of the state. A general discussion of the state's geology and the mechanisms of thermal spring production, along with a brief comparison of Wyoming's springs with worldwide thermal features are included. A discussion of geothermal energy resources, a guide for visitors, and an analysis of the flora of Wyoming's springs follow the spring inventory. The listing and analysis of Wyoming's thermal springs are arranged alphabetically by county. Tabulated data are given on elevation, ownership, access, water temperature, and flow rate. Each spring system is described and its history, general characteristics and uses, geology, hydrology, and chemistry are discussed. (MHR)

GEOTHERMAL EXPLORATION AND EXPLORATION TECHNOLOGY

EXPLORATORY DRILLING AND WELL LOGGING

2902 (SAND—79-1361) **FY79 Lava Lake Drilling Program - geoscience studies; plans and results.** Colp, J.L. (Sandia Labs., Albuquerque, NM (USA)). Oct 1979. Contract EY-76-C-04-0789. 106p. Dep. NTIS, PC A06/MF A01.

Fifteen experimental studies were planned for the geoscience studies portion of the FY79 Lava Lake Drilling Program at Kilauea Iki Lava Lake, Hawaii, grouped under headings of petrologic, thermal, strength, liquid/permeability, electrical, and other. This report gives a location, purpose, description, and feasibility analysis for each experiment. A results section for each experiment includes data gathered and analysis to date, where available.

2903 (SAND—79-0522(Vol.5)(No.1), pp 5-11) **Instrumentation for earth resources extraction.** Northrop, D.A.; Veneruso, A.F. May 1979.

In Sandia technology.

The needs of geothermal technology focused upon the development of high-temperature instrumentation hardware and the development of fossil-energy extraction technologies requiring field-oriented instrumentation efforts aimed at characterization and understanding of in situ processes are described.

ENVIRONMENTAL ASPECTS AND WASTE DISPOSAL

REFER ALSO TO CITATION(S) 2899

2904 (DOE/EV—0046(Vol.3), pp 5) **Identification of environmental issues associated with the utilization of geothermal energy.** Anspaugh, L.R. (Lawrence Livermore Lab., CA). Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

2905 (DOE/EV—0046(Vol.3), pp 6-16) **Overview of H_2S control technology for geothermal energy sources.** Ananth, K.P. (Midwest Research Inst., Kansas City, MO). Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

The control of H_2S emissions from geothermal power plants is discussed briefly. The control options, as presented here, are primarily directed toward: (1) incoming steam (i.e., upstream), (2) condenser vent emissions, and (3) cooling tower emissions. For each category, the major processes are identified along with their advantages and disadvantages. Finally, the processes are intercompared using several selection criteria. These criteria include stage of development of the control technology, its potential for H_2S removal, extent of applicability, cost of control, and secondary environmental problems created, if any.

2906 (DOE/EV—0046(Vol.3), pp 17-34) **Control of H_2S from geothermal power plants by steam scrubbing with copper sulfate solution.** Brown, F.C. (EIC Corp., Newton, MA). Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

The development effort has been carried out in a three phase program which includes fundamental studies at the laboratory scale to define the basic chemistry of the process and to obtain preliminary design data, an engineering design and development effort to demonstrate the applicability of the process on real geothermal steam and to develop the design of a demonstration plant, and the construction and operation of an integrated demonstration plant for the process at a 5 MW scale. The process, which removes hydrogen sulfide at turbine upstream conditions, is based on the chemistry of the acid copper sulfate-hydrogen sulfide system. The essential steps in the process include contacting the steam with copper sulfate solutions, separating the reaction products to purge soluble impurities and to direct the precipitated copper sulfides to regeneration, and regeneration of copper sulfate for recycle. The development program which has been carried out and the current status of the demonstration plant are described. The experimental and analytical work which has been carried out and the preliminary process design criteria for the process will also be presented.

2907 (DOE/EV—0046(Vol.3), pp 35-50) **Removal of H_2S from geothermal steam by catalytic oxidation.** Li, C.T.; Brouns, R.A. (Battelle Pacific Northwest Labs., Richland, WA). Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

The removal of H_2S is necessary for preventing the corrosion of equipment and protecting the environment if geothermal steam is to be utilized for the power generation. A catalytic oxidation to remove H_2S from geothermal steam has been studied in a laboratory bench scale unit. The process uses an old H_2S removal technique in which H_2S is oxidized by O_2 (or air) to form H_2O and elemental sulfur in presence of activated carbon as a catalyst. The process has been proved to be a feasible one in the laboratory. It removes H_2S in simulated geothermal steam from 200 ppM to lower than 20 ppM most of the time. The spent carbon can be regenerated and reused. The next phase of work will be the design of a pilot plant and the evaluation of the process by actual field tests.

2908 (DOE/EV—0046(Vol.3), pp 51) **Subsidence control research program.** Noble, J. (Lawrence Berkeley Lab., CA). Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

2909 (EGG-GTH—5004) **Bruneau Known Geothermal Resource Area: an environmental analysis.** Spencer, S.G.; Russell, B.F. (eds.). (EG and G Idaho, Inc., Idaho Falls (USA)). Sep 1979. Contract EY-76-C-07-1570. 146p. Dep. NTIS, PC A07/MF A01.

The Bruneau Known Geothermal Resource Area (KGRA) is part of the Bruneau-Grandview thermal anomaly, the largest geothermal area in the western US. This part of Owyhee County is the

driest part of Idaho. The KGRA is associated with the southern boundary fault zone of the Snake River Plain. Thermal water, produced from numerous artesian wells in the region, is supplied from two major aquifers. Ecological concerns include the threatened Astragalus mulfordiae and the numerous birds of prey nesting in the Snake River canyon northwest of the KGRA. Extensive geothermal development may strain the limited health care facilities in the county. Ethnographic information suggests that there is a high probability of prehistoric cultural materials being remnant in the Hot Spring locality.

2910 (LBL—8618) **Areas of ground subsidence due to geofluid withdrawal.** Grimsrud, G.P.; Turner, B.L.; Frame, P.A. (Systems Control, Inc., Palo Alto, CA (USA); California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Aug 1978. Contract W-7405-ENG-48. 330p. Dep. NTIS, PC A15/MF A01.

Detailed information is provided on four geothermal areas with histories of subsidence. These were selected on the basis of: physical relevance of subsidence areas to high priority US geothermal sites in terms of withdrawn geofluid type, reservoir depth, reservoir geology and rock characteristics, and overburden characteristics; and data completeness, quality, and availability. The four areas are: Chocolate Bayou, Raft River Valley, Wairakei, and the Geysers. (MHR)

GEOTHERMAL POWER PLANTS

2911 (DOE/ET/28432—1) **Regional systems development for geothermal energy resources: Pacific region (California and Hawaii). Task I: implementation plan development, topical report.** Michler, D.W. (System Development Corp., Santa Monica, CA (USA)). 26 Mar 1979. Contract ET-78-C-03-1530. 509p. Dep. NTIS, PC A22/MF A01.

Eleven implementation plans were prepared. They represent some 21 reservoir-site developments and 48 geothermal power plant developments. The plans consist of three integrated elements: (1) a bar-chart schedule that depicts interdependencies among activities and shows significant milestones on the path from initial exploration to power on-line, (2) task descriptions, and (3) the responsible performers. During the preparation of the implementation plans, the tasks required for resource development at each KGRA were defined on a generalized work breakdown structure (WBS) diagram. A generalized WBS dictionary (task descriptions) was also compiled. In addition, a specific WBS for each KGRA was prepared in a tabular and indented format. The tasks formed the basis for the schedular activities. Institutional responsibilities, based upon the WBS, were identified and are also shown on the tabular WBS. In this manner, implementation plans evolved whose schedular, task, and responsibility elements were integrated with one another. In order to provide logically consistent time estimates, and a reasonable basis for comparison, schedule modules were developed for some recurring activities which are essentially common to all KGRAs. In the preparation of multiple plant schedules for a given KGRA, the interactive effects of power development on the ancillary resources of the area were considered so that interfaces and constraining situations would be identified. Within Imperial County, this process was taken one step further to include the influence that development at the several close-lying KGRAs would have upon one another. A set of recommendations for the accelerated development of geothermal energy resources was prepared and the potential implementors were suggested.

2912 (DOE/ET/28432—2) **Regional systems development for geothermal energy resources: Pacific region (California and Hawaii). Task 2: Regional program monitoring and progress evaluation, topical report.** (System Development Corp., Santa Monica, CA (USA)). 19 Mar 1979. Contract ET-78-C-03-1530. 132p. Dep. NTIS, PC A07/MF A01.

All the objectives of the regional program monitoring and progress evaluation have been met through personal contacts and the review of data. They are as follows: to determine the existing status of power plant projects and future plans; to identify major problem areas for each project (technical, financial, regulatory) that are affecting progress; and to analyze the data and to develop recommendations directed toward resolving problems. The results have been presented in a tabular summary format that is accompanied by explanatory text covering 25 projects.

2913 (DOE/ET/28432—3/1) **Regional Systems Development for Geothermal Energy Resources Pacific Region (California and Hawaii). Task 3: water resources evaluation. Topical report.** Sakaguchi, J.L. (System Development Corp., Santa Monica, CA (USA)). 19 Mar 1979. Contract ET-78-C-03-1530. 375p. Dep. NTIS, PC A16/MF A01.

The fundamental objective of the water resources analysis was to assess the availability of surface and ground water for potential use as power plant make-up water in the major geothermal areas of California. The analysis was concentrated on identifying the major sources of surface and ground water, potential limitations on the usage of this water, and the resulting constraints on potentially developable electrical power in each geothermal resource area. Analyses were completed for 11 major geothermal areas in California: four in the Imperial Valley, Coso, Mono-Long Valley, Geysers-Calistoga, Surprise Valley, Glass Mountain, Wendel Amedee, and Lassen. One area in Hawaii, the Puna district, was also included in the analysis. The water requirements for representative types of energy conversion processes were developed using a case study approach. Cooling water requirements for each type of energy conversion process were estimated based upon a specific existing or proposed type of geothermal power plant. The make-up water requirements for each type of conversion process at each resource location were then estimated as a basis for analyzing any constraints on the megawatts which potentially could be developed.

2914 (DOE/ET/28432—3/2) **Regional systems development for geothermal energy resources: Pacific Region (California and Hawaii). Task 3: water resources evaluation, topical report appendices.** (System Development Corp., Santa Monica, CA (USA)). 19 Mar 1979. Contract ET-78-C-03-1530. 343p. Dep. NTIS, PC A15/MF A01.

The appendices for the water resources evaluation report are included for the Imperial Valley KGRA's, Coso, Mono-Long Valley, Geysers Calistoga, Surprise Valley, Wendell Amedee, Glass Mountain, Lassen, Puna, and for power plant case studies. (MHR)

POWER PLANT SYSTEMS AND COMPONENTS

2915 (LBL—9720) **Baseline data on film coefficient for heating isobutane inside a tube at 4.14 MPa (600 psia).** Tleimat, B.W.; Laird, A.D.K.; Hsu, I.C.; Rie, H. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Apr 1979. Contract W-7405-ENG-48. 7p. (CONF-790808—21). Dep. NTIS, PC A02/MF A01.

From 18. ASME national heat transfer conference; San Diego, CA, USA (Aug 1979).

Research designed to obtain heat transfer baseline data on working fluids in geothermal binary cycle systems is described. The working fluid loop simulates the binary cycle with steam as the heating fluid and a throttling valve instead of the turbine. Data on film coefficient for heating isobutane in the supercritical region (critical pressure 3.65 MPa) inside a tube at 4.14 MPa (600 psia) and at various temperatures and flow rates are presented. The isobutane was heated in a horizontal, type 316 stainless steel, instrumented tube by steam condensing on the outside. The tube was fitted with a total of fifteen thermocouples imbedded in the wall of the tube at 45 deg radially above a horizontal plane through the axis at five stations located equally along the length of the tube. The inside and outside wall temperature of the tube at each of the five stations was calculated from the location of the imbedded thermocouples and their temperatures. The heat rate was determined by measuring the rate of condensing steam on the outside of the tube under each of four sections by means of specially designed vapor-traced meters. The temperature of the isobutane inside the heater tube was measured by means of a traveling platinum resistance thermometer equipped with a mixing head at its tip and the temperature of the steam in the steam chest outside of the tube was measured by means of a platinum resistance thermometer. Film coefficients for the heating of isobutane in the range of 0.6 to 2.5 kW/m^2C (115 to 400 $Btu/hr\ ft^2F$) were obtained for Reynolds number between 3×10^4 to 2×10^5. A plot of these data on log-log paper showed that they are correlated by an empirical equation.

CORROSION, SCALING, AND MATERIALS DEVELOPMENT

REFER ALSO TO CITATION(S) 3356

PROPERTIES OF AQUEOUS SOLUTIONS

REFER ALSO TO CITATION(S) 3425, 3426

TIDAL POWER

ECONOMICS

2916 **Integrating Fundy tidal power.** DeLory, R.P. (Nova Scotia Power Corp., Halifax). *Int. Water Power Dum Constr.;* **31**: No. 9, 37-39(Sep 1979).

Economic utilization of the energy output from the proposed Fundy tidal power project depends critically on Federal support and a high degree of interconnection between the neighboring systems.

WIND ENERGY

REFER ALSO TO CITATION(S) 2897

AVAILABILITY (CLIMATOLOGY)

2917 Wind - electric power: a renewable energy resource for California. Lerner, J. Sacramento, CA; California Energy Commission (1978). 21p. (NP—24141). California Energy Commission, 1111 Howe Ave., Cacramento, CA 95825.

Information on the use of wind energy in California is presented concerning wind turbine technology; availability; market potential; system integration; limits to wind systems development; and government programs in wind energy.

ECONOMICS

REFER ALSO TO CITATION(S) 2917

WIND ENERGY ENGINEERING

TURBINE DESIGN AND OPERATION

2918 (COO—2615-76/2) **Experimental and analytical research on the aerodynamics of wind driven turbines. Final report.** Rohrbach, C.; Wainauski, H.; Worobel, R. (United Technologies Corp., Windsor Locks, CT (USA). Hamilton Standard Div.). Dec 1977. Contract EY-76-C-02-2615. 257p. Dep. NTIS, PC A12/MF A01.

This aerodynamic research program was aimed at providing a reliable, comprehensive data base on a series of wind turbine models covering a broad range of the prime aerodynamic and geometric variables. Such data obtained under controlled laboratory conditions on turbines designed by the same method, of the same size, and tested in the same wind tunnel had not been available in the literature. Moreover, this research program was further aimed at providing a basis for evaluating the adequacy of existing wind turbine aerodynamic design and performance methodology, for assessing the potential of recent advanced theories and for providing a basis for further method development and refinement.

2919 (SERI/TR—35-234) **General reliability and safety methodology and its application to wind energy conversion systems.** Edesess, M.; McConnell, R.D. (Solar Energy Research Inst., Golden, CO (USA)). Sep 1979. Contract EG-77-C-01-4042. 52p. Dep. NTIS, PC A04/MF A01.

In conventional system reliability calculations, each component may be in the Operable state or the Under Repair state. These calculations derive system unavailability, or the probability of the system's being down for repairs. By introducing a third component state between Operable and Under Repair - namely, Defective, But Defect Undetected - the methods developed in this report enable system safety projections to be made in addition to availability projections. Also provided is a mechanism for computing the effect of inspection schedules on both safety and availability. A Reliability and Safety Program (RASP) is detailed which performs these computations and also calculates costs for system inspections and repairs. RASP is applied to a simplified wind energy conversion system example.

SITE CHARACTERISTICS

2920 (PNL—3074) **Estimation of wind characteristics at potential wind energy conversion sites.** (SRI International, Menlo Park, CA (USA)). Oct 1979. Contract EY-76-C-06-1830. 149p. Dep. NTIS, PC A07/MF A01.

A practical method has been developed and applied to the problem of determining wind characteristics at candidate wind energy conversion sites where there are no available historical data. The method uses a mass consistent wind flow model (called COMPLEX) to interpolate between stations where wind data are available. The COMPLEX model incorporates the effects of terrain features and airflow. The key to the practical application of COMPLEX to the derivation of wind statistics is the model's linearity. This allows the input data sets to be resolved into orthogonal components along the set of eigenvectors of the covariance matrix. The solution for each eigenvector is determined with COMPLEX; the hourly interpolated winds are then formed from linear combinations of these solutions. The procedure requires: acquisition and merger of wind data from three to five stations, application of COMPLEX to each of the seven to 11 (depending on the number of stations for which wind data are available) eigenvectors, reconstruction of the hourly interpolated winds at the site from the eigenvector solutions, and finally, estimating the wind characteristics from the simulated hourly values. The report describes the methodology and the underlying theory. Possible improvements to the procedure are also discussed.

2921 Trees as a local climatic wind indicator. Wade, J.E.; Hewson, E.W. (Department of Atmospheric Sciences, Oregon State University, Corvallis 97331). EY-76-S06-2227. *J. Appl. Meteorol.;* **18**: No. 9, 1182-1187(Sep 1979).

The use of trees as a local climatic wind indicator is described. Studies using trees as an indicator of prevailing wind direction, wind speed and as an evidence of the occurrence of severe winds are presented. This paper describes some of the limitations and practical applications of trees in local wind surveys.

ELECTRIC POWER ENGINEERING

REFER ALSO TO CITATION(S) 2815, 3084, 3085, 3086, 3088

2922 (CONF-790595—, pp 4.136-4.149) **Electric energy systems.** Feero, W. (Dept. of Energy, Washington, DC). 1979.

From DOE semi-annual review for photovoltaics; Gatlinburg, TN, USA (16 May 1979).

2923 (TMVK—3067) **Progress report from the Division of Heat and Power Engineering at Lund Institute of Technology, Sweden, 1975-1977.** Torisson, T. (Tekniska Hoegskolan, Lund (Sweden). Inst. foer Vaerme- och Kraftteknik). Jun 1978. 30p. (In Swedish). Dep. NTIS (US Sales Only), PC A03/MF A01.

An account is given for the research activities at the Division of Heat and Power Engineering at Lund Institute of Technology, Sweden, during the period 1975 to 1977. At this division, methods and systems which are important when converting raw energy to refined energy forms in simple or combined processes, are studied.

POWER PLANTS AND POWER GENERATION

REFER ALSO TO CITATION(S) 2464, 2946, 2949, 2950, 2951, 2952, 2953, 3296

2924 (ANL/CNSV-TM—16) **Case study of total energy plant at the Kansas City TWA overhaul base.** (Faucett (Jack) Associates, Inc., Chevy Chase, MD (USA)). 30 Dec 1977. Contract W-31-109-ENG-38. 88p. Dep. NTIS, PC A05/MF A01.

This case study evaluates the reasons for TWA's 1969 decision to build a total energy plant at its Kansas City overhaul base. Total energy was bought on the basis that it would reduce energy costs and, at the same time, provide more reliable and higher quality electric power. Reasons why these expectations did not materialize are analyzed, along with operational statistics, and total energy versus purchased power costs, forming a record that can aid the Department of Energy in determining the energy conservation potential of such applications of total energy in the United States. TWA's present status at the overhaul base is that of buying electric power from the Missouri Public Service Company. Steam produced under the total energy format by waste-heat recovery, is again being produced through the use of the previously existing combustion boiler capacity.

2925 (EPRI-EA—1117) **Users guide to the over/under capacity planning model. Final report.** Clark, C.E.; Keelin, T.W.; Shur, R.D. (Decision Focus, Inc., Palo Alto, CA (USA); Warthman (Forrest) and Associates, Palo Alto, CA (USA)). Jul 1979. 296p. Dep. NTIS, PC A13/MF A01.

The Users Guide is designed to facilitate the application of the Over/Under Capacity Planning Model to specific utility systems. The model was developed in EPRI project RP 1107 for assessing the total costs to consumers of varying levels of planning reserve margin under conditions of uncertain future demand. The methodological basis for the model is described in the October 1978 EPRI report EA-927, Costs and Benefits of Over/Under Capacity in Electric Power System Planning. The Users Guide contains a description of the model's component modules, instructions for operating the model, guidelines for interpreting results and suggested procedures for developing case studies. Detailed data input information is included in the body of the report and reproduced in a separate Quick Guide, which may be removed for use at the computer. A discussion of main program and subroutine logic is provided in the appendix. The Users Guide is intended as a companion for standard FORTRAN IBM and CDC versions of the computer code available from the EPRI Systems Program.

COOLING AND HEAT TRANSFER EQUIPMENT AND SYSTEMS

REFER ALSO TO CITATION(S) 2897, 3609

2926 (ANL/WR—78-5) **Assessment of the once-through cooling alternative for central steam-electric generating stations.** Paddock, R.A.; Ditmars, J.D. (Argonne National Lab., IL (USA)). Dec 1978. Contract W-31-109-ENG-38. 111p. Dep. NTIS, PC A06/MF A01.

The efficacy of the disposal of waste heat from steam-electric power generation by means of once-through cooling systems was examined in the context of the physical aspects of water quality standards and guidelines for thermal discharges. Typical thermal standards for each of the four classes of water bodies (rivers, lakes, estuaries, and coastal waters) were identified. The mixing and dilution characteristics of various discharge modes ranging from simple, shoreline surface discharges to long, submerged multiport diffusers were examined in terms of the results of prototype measurements, analytical model predictions, and physical model studies. General guidelines were produced that indicate, for a given plant capacity, a given type of receiving water body, and a given discharge mode, the likelihood that once-through cooling can be effected within the restrictions of typical thermal standards. In general, it was found that shoreline surface discharges would not be adequate for large power plants (≧ 500 MW) at estuarine and marine coastal sites, would be marginally adequate at lake sites, and would be acceptable only at river sites with large currents and river discharges. Submerged multiport diffusers were found to provide the greatest likelihood of meeting thermal standards in all receiving water environments.

2927 (DOE/EV—0046(Vol.3), pp 332-349) **Overview of the Department of Energy's Meteorological Effects of Thermal Energy Releases (METER) Program.** Rubin, A.M. (Dept. of Energy, Washington, DC); Moses, H.; Eissenberg, D. Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

The objective of the Meteorological Effects of Thermal Energy Releases (METER) Program is to develop methods and a data base to assess the atmospheric effects of heat and moisture releases from large nuclear and fossil energy generating facilities. Included in the program are effects from mechanical and natural draft cooling towers, as well as cooling ponds and canals. The atmospheric effects which are of interest include precipitation modification, fogging and icing, multiple plume interactions, drift deposition, shadowing, and others. The METER program is subdivided into three coordinated elements: (1) field studies, (2) physical modeling, and (3) mathematical modeling. Current studies are primarily directed towards field studies at operating plants. ORNL is carrying out a statistical precipitation study over a several year period at the 3160 MWe Bowen plant in Georgia utilizing a dense raingage network around the plant to determine to what extent normal rainfall patterns are affected by thermal emissions from natural draft cooling towers. A second field study, by PNL, deals with drift deposition and transport from mechanical draft cooling towers. Penn State University is conducting airborne measurements of velocity, temperature, and drift within plumes from a natural draft tower. ANL is conducting a study of the effects of cooling ponds on the environment. In the area of mathematical modeling, the Rand Corporation is conducting numerical model studies to provide a better understanding of the effects on weather phenomena from cooling tower heat releases. PNL is conducting physical model experiments of mechanical draft cooling towers in order to better understand the phenomena of plume interactions between adjacent cooling towers.

2928 (DOE/EV—0046(Vol.3), pp 380-411) **Accomplishments in the Department of Energy program on advanced concepts for dry and dry/wet cooling.** Johnson, B.M. (Battelle Pacific Northwest Labs., Richland, WA). Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

The Dry Cooling Enhancement Program has focused on the development of technology and the initial planning for a large-scale test of an advanced dry/wet cooling concept. The overall program objective is to develop technology to relieve the water shortage anticipated in many sections of the country through encouraging the use of dry cooling of power plants. The development of systems which are less costly, with respect to operating penalties as well as capital, and the transfer of this technology to the commercial market were seen to be essential in order to have any impact on the national problem of growing competition for existing water supplies. The system selected for large scale testing is one which uses ammonia to transfer the waste heat from the turbine to a dry cooling tower and is enhanced by two different ways of incorporating evaporative cooling. One uses a conventional cooling tower close coupled to a water-cooled ammonia condenser, the other uses water evaporated from the surface of the dry tower over which it flows. The five areas of the total DOE program are discussed and include: studies of the anticipated need for dry cooling and the payoff from a successful demonstration of an improved system; evaluation of existing technology to identify areas in which improvements would have major impact; identification of improved systems and the comparisons of projected costs to establish the incentives for further development and large scale testing; testing of critical aspects of the system selected as the leading candidate for large-scale testing; and development of a concensus among various elements of the utility industry as to the wisdom of proceeding with a large scale test and the structuring of a program and a funding base to carry out the test.

2929 (DOE/EV—0046(Vol.3), pp 412-429) **Waste heat management in the electric power industry: issues of energy conservation and station operation under environmental constraints.** Harleman, D.R.F.; Stolzenbach, K.D.; Glicksman, L.R.; Adams, E.E.; Barbera, R.J. (Massachusetts Inst. of Tech., Cambridge). Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

The issues of cost, conversion efficiency and environmental impacts associated with the condenser cooling systems of large steam-electric power plants are discussed. Emphasis is placed on several alternatives to the use of conventional open cycle cooling or wet cooling towers. Particular issues which have been addressed include the effect of replacement energy costs on optimal cooling system size (especially for dry towers), the development of a quasi-steady representation of the transient response of cooling systems with large thermal inertia (e.g., cooling ponds), and the effect of stream standards on the operation and penalty costs of supplementary cooling systems. Furthermore, various cooling systems have been compared at a hypothetical site and the results have been used, along with the data on cooling water availability, to deduce conclusions regarding differences in cooling costs which result from varying environmental controls.

2930 (DOE/EV—0046(Vol.3), pp 430-451) **Supporting studies in heat dissipation.** Helms, I. (Dept. of Energy, Washington, DC); Haberski, R.J.; Bentz, J.C.; Sonnichsen, J.L.; Moore, F. Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

Three studies in support of the DOE heat dissipation effort are described. A study of an improved heat transfer surface by Curtiss-Wright has shown substantially less cost for dry cooling towers; a power plant water data information system at REDL is described, and the Cornell University program on cooling tower wind effects is discussed, together with some possible modifications which may have less wind effect.

2931 (PB—290576) **Optimum combinations of cooling alternatives for stream - electric power plants. Volume II. Final report.** Croley, T.E.; Giaquinta, A.R.; Lee, R.M.H.; Hsu, T. (Iowa Inst. of Hydraulic Research, Iowa City (USA)). Jul 1978. Contract DI-14-31-0001-5201. 185p. NTIS PC A09/MF A01.

An overview of cooling alternatives and detailed system thermodynamics are presented. Two sets of computer models are developed for the analysis of wet tower/cooling pond and wet tower/once-through combination cooling systems. The models are used to study the thermal characteristics, economics, and water consumption of these combination cooling systems. The effects of both meteorological conditions and economic parameters such as various unit costs, are examined in the identification of optimum cooling system configurations for several case studies. The case studies illustrate the most promising cooling system configurations or types of combined cooling systems, which are attractive in their economic or water conservation aspects. It is found that the parallel water path configuration of the wet tower/cooling pond combination cooling system is economically superior to the series water path configurations. For the wet tower/once-through combination cooling system, the type 3 cooling system (which is a series water-path arrangement with a partially closed-cycle loop) appears to be the most attractive one. Comparison of the dry/wet tower system with the wet tower/cooling pond system indicates that the latter is economically superior but has higher water consumption. Finally, it is evident that combination wet tower/once-through cooling systems are economical in comparison with once-through cooling associated with low river heat assimilation capacity.

2932 (RI/RD—78-212B) **Advanced coal-fueled combustor/heat exchanger technology study. Final report, March 1977-June 1978.** (Rockwell International Corp., Canoga Park, CA (USA). Rocketdyne Div.). 1978. Contract EF-77-C-01-2612. 418p. Dep. NTIS, PC A18/MF A01.

The design of coal-fired combustor/heat exchangers suitable for inputing the heat to base-loaded, closed-cycle, gas turbine, 350 MWe, central station power generation systems is discussed. A wide variety of CCGT cycles are evaluated to establish the performance requirements for the combustor/heat exchanger. The cycles finally selected for combustor/heat exchanger design operate at 1550 F, 1750 F, and 2250 F maximum working-fluid temperatures. Each selected cycle is bottomed with a Rankine/steam cycle operating at 2400 psi/1050 F/1050 F. The coal inputs to stations incorporating

the selected cycles are estimated to range from 82 to 88% of the required input to a 2400-psi/1000 F/1000 F conventional steam station. At the 1550 F maximum working-fluid temperature, two combustor/heat exchanger preliminary designs are created, one utilizing the pulverized-coal-fired, dry-bottom furnace firing concept and the other utilizing the atmospheric-pressure, fluidized bed with limestone addition firing concept. At the 1750 F maximum working-fluid temperature, the combustor/heat exchanger preliminary design is based on a series arrangement of high- and low-temperature fluidized beds. At 2250 F maximum working-fluid temperature, the combustor/heat exchanger preliminary design is based on the slagging cyclone combustor concept. Heat exchanger surface exposed to working-fluid temperatures above 1550 F in the last two designs is constructed of silicon carbide. The key technical features of the four preliminary designs are identified and analyzed. Research and development programs to advance the technology of these designs to a state of readiness for commercial application are outlined, and R and D cost estimates are presented. The cost of electricity produced in 700 MWe stations incorporating the studied CCGT cycles and combustor/heat exchangers is estimated and compared with the cost of electricity in conventional steam stations.

2933 **Keep your cool when selectig the right tower.** Kunesch, A.M. *Process Eng.:* 164-165, 167(Sep 1978).

No two cooling towers perform exactly the same duty and special designs are necessary for efficient operation for various parameters. These parameters are discussed and the latest tower designs and developments are examined.

POWER CYCLES

REFER ALSO TO CITATION(S) 3216

2934 (EPRI-AF—1160) **Screening evaluation of electric power cycles integrated with coal gasification plants.** Gallagher, S.P.; Ahner, D.J. (General Electric Co., Schenectady, NY (USA)). Sep 1979. 80p. Dep. NTIS, PC A05/MF A01.

Potentially lower cost alternatives to present concepts for integrated gasification combined cycle power plants have been investigated. The study was initiated based on estimates which showed that steam-bottoming equipment would amount to 25 or 30% of the total capital cost of an integrated gasification combined cycle power plant. The capital saving of removing the steam system was obvious. The question remained whether the efficiency of a lower cost alternative could be high enough to make the system attractive. Consequently, a relatively simple, potentially low cost, non steam-bottomed cycle was evolved and the system thermal efficiency calculated. Thermal efficiencies were also determined for several steam-bottomed cycles. The non steam-bottomed cycle was found to have a thermal efficiency of 32%. However, attainment of this performance level depends on development of hot particulate removal equipment and high performance level depends on development of hot particulate removal equipment and high performance expander turbines beyond the current state-of-the-art. The steam-bottomed cycles analyzed in the study showed efficiency estimates between 38.8 and 40.3%, substantially higher than the non steam-bottomed case. High performance fuel gas expander turbines and their associated hot particulate removal and heat exchange equipment were found to be the most developmental, highest risk items considered in the study. It was also noted that if such equipment was developed, it could be applied to both steam-bottomed and non steam-bottomed cycles. The efficiency for an integrated gasification combined cycle using gas turbines at current firing temperatures was estimated at 37.7%. Performance at this level suggests the possibility that integrated gasification combined cycles using current gas turbines may be attractive for near-term application.

2935 (FE—2357-32) **CFCC Development Program: commercial plant stacked combustor/steam generator design evaluation (Task 2.1).** (Foster Wheeler Development Corp., Livingston, NJ (USA)). Jun 1978. Contract EX-76-C-01-2357. 176p. Dep. NTIS, PC A09/MF A01.

The Coal Fired Combined Cycle (CFCC) is the unique power plant concept developed under the leadership of the General Electric Company to provide a direct coal-burning gas turbine and steam turbine combined cycle power plant. The advantages of the combined cycle for higher efficiency and the potential of the pressurized fluidized bed (PFB) combustor for improvements in emissions could offer a new and attractive option to the electric utility industry after its successful development. The CFCC approach provides cooling of the fluid bed combustor through the use of steam tubes in the bed, which supply a steam turbine-generator. The partially cooled combustion gases exiting from the combustor drive a gas turbine-generator after passing through a hot-gas cleanup train. On the basis of previous studies and confirming work under this contract, General Electric continues to believe that the CFCC approach offers these important advantages over alternate approaches: higher power plant efficiency in the combustor temperature range of interest; reduced combustor/steam generator corrosion potential, due to low fluid-bed tube temperature (as contrasted to the air in tube cycle); reduced hot-gas cleanup flow rate (as contrasted with the uncooled combustor cycle); and increased gas turbine bucket life through use of corrosion resistant material protection systems.

2936 (FE—2357-47) **PFB Coal Fired Combined Cycle Development Program. Quarterly report, July-September 1978.** (General Electric Co., Schenectady, NY (USA). Energy Systems Programs Dept.). 1978. Contract EX-76-C-01-2357. 56p. Dep. NTIS, PC A04/MF A01.

The System Analysis report was completed and is currently undergoing internal review prior to submission to DOE. Exposures of up to 6000 hours in the small burner rigs during Phase II identified PFB-5PM, aluminided PFB-6PM and GE-2541 as the most corrosion resistant cladding alloys. Three alloy modifications each of GE-2541 and PFB-5PM have been ordered as prealloyed powder to evaluate the effect of the modifications. Test 9 at CURL was terminated after twenty-one hours' operation due to a failure in the bellows between the combustor and Aerodyne cyclone. Initial data reduction of the total ninety-one hours of testing (combined Tests 8 and 9) is in progress. All 24 mini-airfoil specimens exposed in the four cascades of the 91 hours CURL PFB Tests 8/9 were received for evaluation. The Aerodyne two-in-one cyclone was removed from the CURL facility and disassembled in order to determine the cause of the anomalies which occurred during Tests # 8 and # 9. The consensus after review and investigation by representatives from Aerodyne, CURL, and GE indicated a number of causes which are detailed. Test planning for the upcoming 1000 hour test at CURL was initiated. Effort is concentrated at integrating the test objectives of the program participants (DOE, EPRI, CURL, GE, AEP, Stal Laval, and B and W Ltd.).

COMPONENTS

REFER ALSO TO CITATION(S) 2932, 3389

2937 (FE—2455-27(Vol.3)) **Conceptual design of an AFBC electric power generating plant. Final Report. Volume III. Appendices.** Kimel, E.; Panico, S.; Bianchini, J.; Novack, M.; Armstrong, J.; Wysocki, J. (Burns and Roe, Inc., Woodbury, NY (USA)). Feb 1979. Contract EF-77-C-01-2455. 328p. Dep. NTIS, PC A15/MF A01.

The US Department of Energy (DOE) awarded a contract to Burns and Roe, Inc. in January 1977 for the Conceptual Design of an Atmospheric Fluidized-Bed Combustion (AFBC) Electric Power Generating Plant. The results of an Interim Report, issued in March 1978, indicate that fluidized-bed technology, as presently developed, offers a potential near term solution to the problems associated with the use of noncompliance coals that may be economically attractive to the electric power utilities. Its successful implementation, thus, has great potential economic benefits to the industry as well as the strategic interests of the country in reducing the dependence on petroleum products. Based on the findings presented in the Interim Report, DOE authorized Burns and Roe to proceed with further detailed investigations in a number of areas. The appendices to the final report contain information on: coal and limestone preparation; fluidized-bed combustor performance; boiler design, performance, and cost; the development of model facilities for boiler performance testing; projections on the limestone feed requirements for a 600 MWe AFBC plant using subbituminous western coal; testing with such coals; and limestone availability in the US. (LCL)

OFF-PEAK ENERGY STORAGE

REFER ALSO TO CITATION(S) 3108, 3110, 3112, 3114, 3120

FUELS

REFER ALSO TO CITATION(S) 2472, 3201

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 2945, 2955, 3579, 3580

THERMAL EFFLUENTS

REFER ALSO TO CITATION(S) 3614, 3615, 3649

NOXIOUS GAS AND PARTICULATE ABATEMENT AND CONTROL

REFER ALSO TO CITATION(S) 2459, 2460, 2926, 3191, 3595

2938 (ANL/ECT—5) **Control technology for fine-particulate emissions.** (Manhattan Coll., New York (USA). Dept. of Chemical

Engineering). Oct 1978. Contract W-31-109-ENG-38. 216p. Dep. NTIS, PC A10/MF A01.

This report presents a detailed review and critical evaluation of current control technologies as applied to fine particulate emissions from coal-fired utility boilers. Topics reviewed are: sources and characteristics of coals and fly ash; performance characteristics of various types of coal-fired utility boilers; design, operation, performance and maintenance features of the conventional control devices (electrostatic precipitator, fabric filter baghouse, wet scrubber), and descriptions of (and where available, performance data on) novel control devices. The report also includes quantitative assessments of the capabilities of both conventional novel devices to meet three different performance standards - the present New Source Performance Standard (NSPS) of 0.1 lb particulate per MBtu heat input, and standards of 0.05 and 0.03 lb particulate per MBtu. Each of the three conventional devices is compared and rated with respect to eight different performance categories. This information is presented in charts, which can be used to determine the relative effectiveness and attractiveness of these three control devices. The novel devices are compared and rated in the same manner. The major conclusions of the report are: (1) The use of conventional scrubbers for fine particulate control on coal-fired utility boilers will no longer be feasible should a more stringent NSPS be promulgated. (2) At the present NSPS, conventional electrostatic precipitators and baghouses are competitive. For a stricter standard, however, the baghouse will become a more attractive alternative than the precipitator. (3) Novel devices appear to offer almost no hope for this particular application (at a commercial level) between now and 1985 and only little hope before 1990.

2939 (DOE/EV—0046(Vol.1), pp 177-198) **Low NO/sub x/ heavy fuel combustor concept program.** Facey, J.R. (Dept. of Energy, Washington, DC); Niedzwiecki, R.W. Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

The objectives of this program are to generate and demonstrate the technology required to develop durable gas turbine combustors for utility and industrial applications, which are capable of sustained, environmentally acceptable operation with minimally processed petroleum residual fuels. The program will focus on dry reductions of oxides of nitrogen (NO/sub x/) and improved combustor durability while using minimally processed petroleum residual fuels. Other technology advancements sought include: fuel flexibility for operation with petroleum distillates, blends of petroleum distillates and residual fuels, and synfuels (fuel oils derived from coal or shale); acceptable exhaust emissions of carbon monoxide, unburned hydrocarbons, sulfur oxides and smoke; and retrofit capability to existing engines.

2940 (DOE/EV—0046(Vol.1), pp 199-216) **Assessment of energy and economic impacts of particulate control technology in coal-fired power plants.** Ramanathan, V.; Reigel, S.; Gorman, P.; Reider, P. (Midwest Research Inst., Kansas City, MO). Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

Midwest Research Institute has carried out a project, under a contract with Argonne National Laboratory, to assess the economic and energy impacts of particulate control systems in coal-fired power plants. The assessment was based on major functional variables such as plant size (100 to 1000 MWe), location, coal type, and emission standards. The work resulted in the generation of algorithms to predict equipment cost, installation costs, and energy usage for various particulate control devices. The devices considered were electrostatic precipitators (hot side and cold side), fabric-filters (reverse air and shaker types), and wet scrubbers. First, a boiler performance model was developed using variables such as plant size, coal characteristics, etc. The output from this model (i.e., flue gas flow rate, grain loading, etc.), then was utilized in control device performance models to generate required design and operating parameters for the control systems under study. These design and operating parameters were then used in the cost models. The cost models aggregate three cost items: the first costs (capital investments), total first-year annualized costs and the integrated cost of ownership and operation of the control equipment over an assumed plant lifetime of 30 years. The models have been programmed for speedy computation. However, the algorithms are easily solvable with a hand calculator. In addition, suitable guideline values have been provided for independent variables wherever necessary. Ample case studies are presented to demonstrate use of the models.

2941 (DOE/EV—0046(Vol.1), pp 217-236) **Control of western power plant sulfur dioxide emissions: development of the ash-alkali FGD process and dry adsorption techniques at the Grand Forks Energy Technology Center.** Ness, H.M.; Selle, S.J. (Dept. of Energy, Grand Forks, ND). Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

Fly ashes from the combustion of many Western and Gulf Coal lignites and subbituminous coals contain high concentrations of alkali which can be used in a wet scrubber for removal of SO_2. Additionally, dry methods of flue gas desulfurization will be required for new and retrofit power installations in some water-scarce areas in the western US. The Grand Forks Energy Technology Center of DOE has performed tests on utilizing fly ash in lieu of lime/limestone on a 130-scfm laboratory scrubber and a 5000-acfm pilot scrubber operated on a stack gas slipstream at a utility burning North Dakota lignite, and on dry sorbents and injection techniques in a 75-lb/hr pulverized coal-fired pilot combustor. In this report, experimental results are presented on: (1) utilization of fly ash alkali in a wet scrubber; and (2) a series of tests designed to evaluate trona and nahcolite as dry sorbents for SO_2 control. Ash alkali wet scrubber results include the correlation of SO_2 removal, alkali utilization, and rate of scale formation with operating conditions such as feed stoichiometric ratio (Ca/S), liquid-to-gas ratio (L/G), pH, and the concentrations of suspended and dissolved solids. Results on dry adsorption of SO_2 include injection into the flue gas with subsequent collection in (1) a pilot ESP, and (2) a pilot baghouse. Temperatures of injection and residence times were varied to simulate full-scale conditions; the points of injection ranged from direct addition into the flame along with the coal, to addition at the inlet of a cold-side ESP or baghouse. Data on SO_2 removal efficiency and reagent utilization are correlated with test conditions. A parallel laboratory study on the kinetics of reactions between the dry sorbents and flue gas SO_2 and NO/sub x/ are also described.

2942 (EPRI-FP—1145) **Evaluation of the George Neal No. 3 electrostatic precipitator. Final report.** Ensor, D.S.; Cowen, S.; Hooper, R.; Markowski, G. (Meteorology Research, Inc., Altadena, CA (USA); Stearns-Roger, Inc., Denver, CO (USA)). Aug 1979. 230p. Dep. NTIS, PC A11/MF A01.

The electrostatic precipitator at the Iowa Public Service Company, George Neal No. 3 near Sioux City, Iowa, was evaluated with a field performance test and engineering analysis. The overall collection efficiency determined with impactors was 99.7 percent at 520 MW with outlet mass concentrations of 0.025 lb/10^6 Btu. The stack opacity was measured to be 4.6 percent. The unit capital cost was $52/gross kW. The operating costs are 1.6 mill/kWh for 1979, based on a 70 percent capacity factor. The major mechanical problems directly related to performance were plugging of ash hoppers, unreliable hopper level indicators, and the ash removal system. The ESP system reliability was 98.4 percent and the T-R set reliabiity ranged from 91 to 100 percent.

2943 **FGD demonstration points to regenerable future.** Wood, R. *Process Eng.;* 146-147, 149(Sep 1978).

North Indiana Public Service Company operates the 115-MW coal-fired power generation station No. 11 at the Dean Mitchell generating station. A Wellman-Lord/Allied Chemical flue gas desulfurization plant and an Allied Chemical SO_2 reduction system are incorporated in the plant. Some construction criteria are noted and the operation of the desulfurization unit is described. The SO_2, from which the water has been removed in the condenser, is compressed in a liquid ring compressor for piping to the Allied Chemical unit, where it is converted to sulfuric acid. The economics of the process is discussed. (MCW)

2944 (SAND—79-8659) **New real-time isokinetic dust mass monitoring system.** Wang, J.C.F.; Patashnick, H.; Rupprecht, G. (Sandia Labs., Livermore, CA (USA); Rupprecht and Patashnick Co., Englewood, CO (USA)). Oct 1979. Contract EY-76-C-04-0789. 37p. Dep. NTIS, PC A03/MF A01.

A new real-time dust mass monitor is being developed by combining an automatic isokinetic sampling probe with a tapered-element oscillating microbalance (TEOM). Particulates from a stack are sampled on line through the isokinetic sampler and collected on an astroquartz mat filter of the TEOM detector. The filter is originally excited and oscillated at a low frequency (about 200 Hz). As the particulates deposit on the filter, the mass increase of the filter is reflected in a frequency reduction which is measured in real time and yields directly the collected particulate mass. The TEOM detector normally has a high mass resolution (10^{-9} g) and wide dynamic range (10^5 to 10^6). It has been desensitized for high particulate loading applications. The integrated monitoring system was tested in a room-temperature wind-tunnel flow with externally injected particulates. Good agreement was obtained between the mass collected through the isokinetic sampling system and the weight loss of the dust feeder in real time.

SITE SELECTION AND LAND USE

REFER ALSO TO CITATION(S) 3203

2945 (CDL-LU—78) **Site selection for coal-fired power plants on the Swedish coast.** (Centrala Driftledningen, Stockholm (Sweden)). Jul 1978. 103p. (In Swedish). 107.

The report presents an inventory of 20 possible sites for coal fired power plants at the Swedish coast. Detailed maps of the sites

are given, local effects are mentioned. Five preferred sites are selected.

POWER TRANSMISSION AND DISTRIBUTION

2946 (CONF-790904—P1) **Systems engineering for power: emergency operating state control.** Fink, L.H.; Trygar, T.A. (eds.). (Department of Energy, Washington, DC (USA). Office of Energy Technology). Oct 1979. Contract EX-76-C-01-2073;EX-76-C-01-2074;EX-76-C-01-2075;EX-76-C-01-2076. 594p. Dep. NTIS, PC A25/MF A01.

From Systems engineering for power: emergency operating state control conference; Davos, Switzerland (30 Sep 1979).

Four meeting sessions at which 30 papers were presented are included in this volume. A separate abstract was prepared for each session. (LCL)

2947 (CONF-790904—P1, pp 135p, Section I) **Monitoring, evaluation and control of power system emergencies.** Zaborszky, J.; Whang, K.W.; Prasad, K.V. (Washingtonn Univ., St. Louis, MO). Oct 1979.

From Systems engineering for power: emergency operating state control conference; Davos, Switzerland (30 Sep 1979).

A comprehensive approach to the control of the large interconnected power system in conditions ranging from normal to disintegrated is outlined. The basic decision is between normal and abnormal conditions or, more precisely, on the degree of abnormality with normality rating as zero degree abnormality. The applicable control algorithms would then be aimed at maintaining normalcy when it is present or leading the system back to normalcy with the least disruption when the condition is abnormal. To lead the system back to normalcy five regimes of control are defined and the measures and means used in each are defined and developed. New ancillary algorithms to use as tools in these operations have been developed. An illustration of a sequence of emergency events under decision and control operation is also included. A measure of the effectiveness of the new techniques is a consistent tenfold increase of critical clearing times. This indicates a large potential savings in new transmission equipment.

2948 (CONF-790904—P1, pp 197p, Section II) **Emergency operating state control on bulk interconnected power systems.** Meisel, J.; Sen, A.; Lequarre, J.; Gilles, M. (Wayne State Univ., Detroit, MI). Oct 1979.

From Systems engineering for power: emergency operating state control conference; Davos, Switzerland (30 Sep 1979).

The research results presented deal with the problem of augmenting transient stability margins of a bulk interconnected electric power system. When subjected to a severe disturbance this system can move from a normal state to an emergency state, wherein the system is viable with generation levels sufficient to meet the customer load. Using an observationally decoupled control space developed in a companion project by Professors Zaborszky and Subramanian, the present state of a small subsystem is obtained with respect to an estimate of an equilibrium state from a localized set of available measurements. Optimal aim strategy (OAS) techniques introduced by Professor Barnard are used to select a desired control effort to move this subsystem instantaneously towards this equilibrium based on a localized low-order crude model formulated in this decoupled space. In order to realize these desired control forces in the fraction of a second time frame of the emergency state control problem, switched electrical elements in the interconnecting network are selected as control means. Primarily this research deals with shunt braking resistors and series braking capacitors directly associated with each coherent subsystem as means to implement the desired control effort selected by the OAS algorithm. The usefulness of these concepts is demonstrated through an extensive set of tests on a number of simulated bulk power systems. The essential features and results of these tests, including system data and computer listings, are included.

2949 (CONF-790904—P1, pp 88p, Section III) **Emergency state control of slow speed dynamics.** Schweppe, F.C.; Wormley, D.N.; Wilson, G.L. (Massachusetts Inst. of Tech., Cambridge). Oct 1979.

From Systems engineering for power: emergency operating state control conference; Davos, Switzerland (30 Sep 1979).

This final report of the Slow Speed Dynamics, Emergency State Control Project, contains eight chapters and two appendices with information on: the basic approach and major conclusions drawn with regard to the overall control strategy; a reformulation of the conventional economic dispatch problem to include a constraint on maximum frequency deviation following a postulated disturbance; the real time control of slow speed dynamics during emergency state conditions; a particular nonlinear static optimization problem which involves determination of real and reactive nodal injections, voltage magnitudes, and local shedding actions so as to find an ac load flow solution which does not violate constraints on voltage magnitudes and line loadings; a technique for identifying low order models of power plants; the development of a physically based mathematical model for a drum boiler turbine generator unit that is valid under emergency state conditions; the implementation of the boiler turbine models in analog form on the MIT-EPSEL model power system; the development of a physically based mathematical model of a supercritical once-through boiler-turbine-generator unit that is valid under emergency state conditions; the overall control strategy; and the MIT-EPSEL model power system which provided the test facility for the overall project. (LCL)

2950 (CONF-790904—P1, pp 141p, Section IV) **Transient energy stability analysis.** Athay, T.; Sherkat, V.R.; Podmore, R.; Virmani, S.; Puech, C. (Systems Control, Inc., Palo Alto, CA). Oct 1979.

From Systems engineering for power: emergency operating state control conference; Davos, Switzerland (30 Sep 1979).

The overall objective of this project was to develop the transient energy method to the point where it is a useful tool for the analysis of power system transient stability. The major accomplishments of the project include: the clear understanding and verification of the fact that by appropriately accounting for fault location in the transient energy method, the stability of a multimachine system can be accurately assessed; the development of techniques based on the Transient Energy Stability Analysis (TESA) approach for the direct assessment of critical clearing times; the development of a formalism for the TESA approach which is based on a Lyapunov theory that involves the concept of invariant sets; the definition of the Potential Energy Boundary Surface (PEBS) which forms the basis for an important instability conjecture and allows for significant improvement in direct stability assessments to be made; the investigative study of the impact of detailed generator models on the basic TESA methodology; and the extensive evaluation of the TESA approach which has clearly demonstrated the usefulness of the basic methodology. The results achieved show that the transient energy method of stability analysis has evolved to a point where a number of practical applications may develop in the near future. (LCL)

2951 (CONF-790904—P3, pp 1.1-1.162) **Multimodeling by singular perturbations.** Kokotovic, P.V. (ed.). Oct 1979.

From Systems engineering for power: emergency operating state control conference; Davos, Switzerland (30 Sep 1979).

Multimodeling is discussed. Realistic situations in which the decision makers in a large scale system use different simplified models of the same system are described. An example is a multi-area power system. The decision maker in one area uses a detailed model of his area and only some lower order equivalents of the neighboring areas. The decision makers in other areas behave in a similar way and as a result each has his own view of the same large scale system. The strategies designed with such inconsistent models are then applied to the actual system. The purpose of this research was to investigate the effect of the multimodeling inconsistencies on the design and implementation of control strategies. The approach taken is perturbational. Chapters are included on the mathematical fundamentals of singular perturbations; iterative algorithms for the time scale separation of linear dynamic systems; near-optimum regulators for systems with slow and fast modes; design of feedback controls; controllability in linear time-variant perturbed systems stability of perturbed systems; control strategies, and analysis of feedback systems. (LCL)

2952 (CONF-790904—P3, pp 2.1-2.183) **Multilevel strategies with reduced models.** Cruz, J.B. Jr. (ed.). Oct 1979.

From Systems engineering for power: emergency operating state control conference; Davos, Switzerland (30 Sep 1979).

Control theories for sequential decision-making for dynamic systems, i.e., leader-follower strategies, and for simultaneously chosen decision-making, i.e., Nash strategies, and the mathematical derivation of these theories are discussed in detail, and the impact of singularly perturbed reduced order models on the determination of simplified strategies is described. (LCL)

2953 (CONF-790904—P3, pp 3.1-3.134) **Chained aggregation and decentralized control.** Medanic, J.V.; Perkins, W.R. (eds.). Oct 1979.

From Systems engineering for power: emergency operating state control conference; Davos, Switzerland (30 Sep 1979).

Research on modeling and synthesis of regulators compatible with the constraints imposed by the information and interconnection structures of large-scale power systems is described. Three basic problems are discussed: reduced order modeling induced by the information and interconnection structure; hierarchial decomposition of control tasks based on the input-output structure of the system; and design of static and dynamic regulators for centralized and decentralized control. In addition, results on two topics relevant to the analysis of the above problems are described, namely: structural properties of linear time-invariant systems, and geometric properties of the algebraic and differential matrix Riccati equation.

2954 (COO—4305-1) **Control of the power system in the normal state. Final report.** Zaborszky, J.; Mukai, H.; Singh, J.; Spare, J.H. (Washington Univ., St. Louis, MO (USA). Dept. of Systems Science and Mathematics). 31 Aug 1979. Contract EC-77-S-02-4305. 46p. Dep. NTIS, PC A03/MF A01.

The economic dispatch and load frequency control problem is approached from scratch as a design for digital computer control with system theoretic foundations, but, the ingenious insights gained in the past 30 y of practice are utilized. In Part I, an estimation process is proposed which gives a much tighter estimate of the Area Load Excess (ALE) over the scheduled load than the traditional Area Control Error (ACE), while it also provides an extrapolated estimate into the future as well as an estimate of the turbine power at each unit. The latter is needed for unit control. Part II introduces a three stage algorithm to generate extrapolated target curves for the individual units to follow for economically matching the area load demand throughout the day. The three stages of the algorithm involve successively shrinking time horizons (one day, one half hour, and one half minute) along with detailed knowledge of the actual load variations and progressively more detailed descriptions of the system. Each algorithmic stage draws on the results of the preceding stage and retains those features of the results which depend on the longer horizon of the preceding stage. The Part 2 algorithm leans, for load data, on the estimation process presented in Part I. The final output is target curves reaching about 1/2 minute into the future, which will be tracked by the power plant controls. This tracking will be discussed in the forthcoming Part III. If the estimation were exact and the unit control instantaneous, the resulting dispatch would be of precisely minimum cost and would be always on schedule in frequency and tie line load. In terms of actual filter and control dynamics this solution will be effective and indeed optimal.The algorithm can readily incorporate such features as control of inadvertent exchange and jointly owned units, but this incorporation is not discussed in this report.

2955 (DOE/EV—0048/1) **Review of state/federal environmental regulations pertaining to the electrical effects of overhead transmission lines: 1978.** Shah, K.R. (Shah and Associates, Inc., Gaithersburg, MD (USA)). Oct 1979. Contract EV-78-X-01-1802. 73p. Dep. NTIS, PC A04/MF A01.

A review of environmental regulations pertaining to the electrical effects of overhead transmission lines is presented. The report discusses environmental regulations of all the states and Federal agencies and gives any quantitative values available. Electrical environmental effects are classified as: corona-generated effects; induced voltage effects on humans, animals, and metallic objects resulting from electrostatic and electromagnetic coupling; ground-current potential effects; and conductive coupling effects. Both radio and television interferences are discussed. Corona-generated ion drift phenomena of HVDC lines, audible noise emission, and ozone generation are also discussed. A brief summary of these electrical effects precedes each discussion of the regulations. 104 references. (MCW)

2956 (EPRI-EL—530) **New class of additives to inhibit tree growth in solid extruded cable insulation. Final report.** Devins, J.C.; Rzad, S.J. (General Electric Co., Schenectady, NY (USA)). Jul 1979. 86p. Dep. NTIS, PC A05/MF A01.

Ferrocene (5%) inhibits treeing and raises the needle-plane breakdown voltage by approximately 100%. However, it is unstable (oxidizes) both in air and in the presence of dicumylperoxide. None of the antioxidants investigated stabilized ferrocene. The effectiveness of ferrocene is not due to an increase in intrinsic dielectric stength, or electron scavenging properties, but seems to be related to the low ionization potential of the compound. The mechanisms are discussed. Nine other related compounds have been found to be ineffective or oxidatively unstable. Low-frequency dielectric studies indicate that the lack of effectiveness of most of the ionic compounds investigated previously was due to an unexpected frequency dependence of field-enhanced dissociation. A new ionic compound, α-bromolauric acid, has been found to be effective in steel-needle breakdown tests at 60 Hz. Although it is oxidatively stable, results suggest that its performance may be specific to systems where field enhancement occurs at iron imperfections. Long-term tests at room temperature show a large improvement in breakdown voltage; however, at 85°C reactions involving iron result in the formation of large voids that completely bridge the needle-to-plane test gap. The most important result of the two studies into additives for inhibiting tree growth in solid extruded cable insulation has been the finding, backed by supporting information on the mechanisms involved, that one can significantly inhibit treeing and raise the breakdown stength. Unfortunately, the materials identified have all suffered from thermal and oxidative instability.

AC SYSTEMS, EHV AND UHV

REFER ALSO TO CITATION(S) 2969, 3480

2957 (COO—4610-T2) **Effects of compressive forces in pipe type cable.** Bunin, B.L. (Rensselaer Polytechnic Inst., Troy, NY (USA)). Jun 1979. Contract EM-78-S-02-4610. 101p. Dep. NTIS, PC A06/MF A01.

Within the thermo-mechanical bending (TMB) phenomenon of underground power transmission systems, compressive cable forces give rise to increasing tape tensions in the cable insulation. Because of their substantial magnitude, these changes in tape tensions play an important role in the formation of soft spots which can eventually cause electrical failure. A theory of the mechanical behavior of power cables under compressive load is presented together with experimental verification of this theory. It may be noted that this theory is basic to the computation of gross moduli that are to be used in the in-situ analysis of cable deformation, and should also provide important additional design criteria for future cable manufacturing.

2958 (DOE/EV—0046(Vol.3), pp 227-242) **Transmission line environmental effects: an operating utility viewpoint.** Gehrig, E.H.; Lee, J.M. Jr. (Bonneville Power Administration, Portland, OR). Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

Nearly all man-made systems cause some environmental effects. The operating electrical utility realistically seeks to identify these effects, develop mitigating measures where necessary, and make management decisions which achieve a balance between maintaining low electricity costs, protecting the quality of the environment, and assuring the realiability of service demanded by its customers. The significant environmental issues, both biological and nonbiological, in construction, operation, and maintenance of the Pacific Northwest Transmission System are described. The discussion covers the influence on system planning alternatives, design options, and measures to protect the environment. A case for advancement of transmission technology to 1100 kV is presented.

2959 (DOE/EV—0046(Vol.3), pp 243-255) **Audible noise from high-voltage transmission lines: psychoacoustic findings.** Molino, J.A.; Lerner, N.D.; Zerdy, G.A. Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

Extra-high voltage (EHV) transmission lines often produce audible (corona) noise during moist weather conditions. A series of experiments was conducted to determine how aversive this noise is to people. These experiments employed recorded samples of corona noise, other environmental noises and artificial reference stimuli. Corona noise samples were found to be equally preferred to other noise samples that were approximately 10 dB higher in sound pressure level than the corona noises. Corona noise was significantly less preferred than the ambient noises occurring near the transmission lines. These findings were true regardless of whether or not the research participants knew that the source of the corona noise was a power line. There were significant differences in preference for different samples of corona noise recorded from different lines. These differences were also observed when the corona noise samples were adjusted to have equal A-weighted sound levels. High-frequency components of corona-noise spectra (>500 Hz) contributed most to the aversiveness of the noise. While all of the commonly used frequency weighting scales correlated strongly with preference, D-weighted sound level provided the highest correlation with the preference data and the smallest standard error bands.

2960 (DOE/EV—0046(Vol.3), pp 256-269) **Effects of high intensity 60 Hz electric fields on primate behavior.** Feldstone, C.S. (Southwest Research Inst., San Antonio, TX). Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

The increasing need for ultra high voltage power lines raises the serious question of what effects exposure to high intensity electric fields will have on both human beings and infra-human species. A preliminary study is underway to develop and thoroughly test the experimental protocols and apparatus which are planned for a major study of the behavioral and biological effects of high intensity 60 Hz electric fields. The African baboon (Papio anubis and Papio cynocephalus) has been chosen as an animal model for the examination both of individual performance (operant conditioning) and natural (social) behavior. There is special interest in possible effects on the higher integrative functions of the central nervous system. The behavior of baboons is being observed before, during, and after exposure to 60 Hz electric fields at a maximum intensity of 60 kV/m. Presently, the first group of subects is being exposed. The apparatus, experimental protocol and planned future studies are described. The studies will first determine what kinds of effects (if any) occur at a 60 kV/m field intensity and then determine the intensities of exposure at which effects are just barely noticeable. This and other similar studies should provide the basis for future exposure standards.

2961 (EPRI-EL—1104(Vol.1)) **Diagnostic program document. Volume 1. User's guide. Final report.** Cate, E.G.; Dembart, B. (Boeing Computer Services Co., Seattle, WA (USA). Energy Technology Applications Div.). Jun 1979. 141p. Dep. NTIS, PC A07/MF A01.

The Diagnostic Program was developed at Boeing Computer Services (BCS) as a tool for studying algorithms used by transient stability computer programs. The Diagnostic Program is a highly modularized transient stability program with specialized outputs. It is the purpose of this document to make the Diagnostic Program accessible to researchers studying algorithms for transient stability. The document consists of three volumes. This volume, Volume I, is a user's guide, including job control language, and examples.

2962 (EPRI-EL—1104(Vol.2)) **Diagnostic program document. Volume 2. Program modification. Final report.** Cate, E.G.; Dembart, B. (Boeing Computer Services Co., Seattle, WA (USA). Energy Technology Applications Div.). Jun 1979. 212p. Dep. NTIS, PC A10/MF A01.

The Diagnostic Program was developed at Boeing Computer Services (BCS) as a tool for studying algorithms used by transient stability computer programs. The Diagnostic Program is a highly modularized transient stability program with specialized outputs. It is the purpose of this document to make the Diagnostic Program accessible to researchers studying algorithms for transient stability. The document consists of three volumes. This volume, Volume II, is a program and installation manual.

2963 (EPRI-EL—1104(Vol.3)) **Diagnostic program document. Volume 3. DSPSI program listings. Final report.** Cate, E.G.; Dembart, B. (Boeing Computer Services Co., Seattle, WA (USA). Energy Technology Applications Div.). Jun 1979. 191p. Dep. NTIS, PC A09/MF A01.

The Diagnostic Program was developed at Boeing Computer Services (BCS) as a tool for studying algorithms used by transient stability computer programs. The Diagnostic Program is a highly modularized transient stability program with specialized outputs. It is the purpose of this document to make the Diagnostic Program accessible to researchers studying algorithms for transient stability. The document consists of three volumes. This volume, Volume III, is a program listing.

2964 (EPRI-EL—1150(Vol.1)) **Distribution data base design. Final report.** Inglis, D.J. (Boeing Computer Services Co., Seattle, WA (USA). Energy Technology Applications Div.). Aug 1979. 59p. Dep. NTIS, PC A04/MF A01.

The overall objective of this project was to perform research into the design of an integrated Distribution Data Base and to provide utilities with guidelines for economic evaluation and implementation of this design. The design must permit system growth, provide for future needs, and allow incremental implementation. The research objectives were accomplished by dividing the project into four major tasks: state-of-the-art study, functional requirements definition, data base system design, and economic evaluation. Volume 1 of this final report documents the steps leading up to the data base design, the details of that design, and its implications for a physical implementation and summarized the results of the project. Two major conclusions can be stated: the Distribution Data Base is an achievable goal as evidenced by the conceptual data base design that was developed, and the conceptual design has a network structure which reflects the multiple-association relationship of the data. It is recommended that this conceptual design of a Distribution Data Base system be implemented on a pilot basis.

2965 (EPRI-EL—1150(Vol.2)) **Distribution data base design. Final report.** Inglis, D.J. (Boeing Computer Services Co., Seattle, WA (USA). Energy Technology Applications Div.). Aug 1979. 308p. Dep. NTIS, PC A14/MF A01.

The overall objective of this project was to perform research into the design of an integrated Distribution Data Base and to provide utilities with guidelines for economic evaluation and implementation of this design. The design must permit system growth, provide for future needs, and allow incremental implementation. The research objectives were accomplished by dividing the project into four major tasks: state-of-the-art study, functional requirements definition, data base system design, and economic evaluation. Volume 2 is oriented towards persons whose background and interests are in a utility's distribution department. It contains material describing the functional capabilities of the Distribution Data Base and its economic evaluations.

2966 (EPRI-EL—1150(Vol.3)) **Distribution data base design. Final report.** Inglis, D.J. (Boeing Computer Services Co., Seattle, WA (USA). Energy Technology Applications Div.). Aug 1979. 122p. Dep. NTIS, PC A06/MF A01.

The overall objective of this project was to perform research into the design of an integrated Distribution Data Base and to provide utilities with guidelines for economic evaluation and implementation of this design. The design must permit system growth, provide for future needs, and allow incremental implementation. The research objectives were accomplished by dividing the project into four major tasks: state-of-the-art study, functional requirements definition, data base system design, and economic evaluation. Volume 3 presents the Distribution Data Base design and its practical implications.

2967 **BPA 1100 kV transmission system development--planning program, and objectives.** Gens, R.S.; Gehrig, E.H.; Eastvedt, R.B. New York, NY; Institute of Electrical and Electronics Engineers, Inc. (1979). 6p. (CONF-790214—).

From 1979 winter power meeting; New York, NY, USA (4 Feb 1979).

BPA is a Federal agency charged with transmitting and marketing power generated at Federal hydroelectric projects in the Pacific Northwest (PNW). This paper summarizes current system planning studies for application of 1100 kV to the Pacific Northwest transmission system, the associated test and development program, and construction of two test lines. It compares 500 and 1100 kV costs and shows 1100 kV to be economical at loadings above 4,000-5,000 MW. The two test lines consist of 1200 kV Lyons Electrical Prototype Line at Lyons, Oregon, and the 1200 kV Moro Mechanical Test Line at Moro, Oregon.

DC SYSTEMS

2968 (LA-UR—79-2774) **Stabilization unit for Bonneville Power Administration.** Schermer, R.I. (Los Alamos Scientific Lab., NM (USA)). 1979. Contract W-7405-ENG-36. 7p. (CONF-791075—2). Dep. NTIS, PC A02/MF A01.

From International symposium on superconductive energy storage; Osaka, Japan (8 Oct 1979).

The Bonneville Power Administration operates the transmission system that joins the Pacific Northwest and southern California. A 30-MJ (8.4 kWh) Superconducting Magnet Energy Storage (SMES) unit with a 10-MW converter can provide system damping for low frequency oscillations. The unit is scheduled to operate in 1982. Progress during FY 79 is described, including the details of mechanical and electrical testing of prototype conductors and the design, specification, and procurement activities for the energy storage coil, nonconducting dewar, electrical system, and cryogenic system.

SUPERCONDUCTING AND CRYOGENIC SYSTEMS

REFER ALSO TO CITATION(S) 3486, 3511

2969 (CONF-790904—P3) **Systems engineering for power: organizational forms for large scale systems. Volume II.** Fink, L.H.; Trygar, T.A. (eds.). (Department of Energy, Washington, DC (USA). Office of Energy Technology). Oct 1979. Contract EX-76-C-01-2073;EX-76-C-01-2074;EX-76-C-01-2075;EX-76-C-01-2076. 487p. Dep. NTIS, PC A21/MF A01.

From Systems engineering for power: emergency operating state control conference; Davos, Switzerland (30 Sep 1979).

Three meeting sessions at which 50 papers were presented are included in this volume. A separate abstract was prepared for each session. (LCL)

2970 (DOE/NASA—0207-79/3) **Measurements of mixed convective heat transfer to low temperature helium in a horizontal channel.** Yeroshenko, V.M.; Kuznetsov, Y.V.; Shevchenko, O.A.; Hendricks, R.C.; Daney, D.E. (Krzhizhanovskij Ehnergeticheskij Inst., Moscow (USSR); National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center; National Bureau of Standards, Boulder, CO (USA). Inst. for Basic Standards). 1979. 17p. (NASA-TM—79158; CONF-790901—1). Dep. NTIS, PC A02/MF A01.

From 15. international congress on refrigeration; Venice, Italy (23 Sep 1979).

A horizontal 2.85-m-long, 19-mm-i.d. stainless steel heated circular channel has been employed to measure coefficients of heat transfer to low temperature helium flow. Experimental parameters range from 6.5 to 15°K, from 0.12 to 0.3 MPa at heat fluxes up to 1000 W/m^2 and Reynolds numbers from 9.10^3 to 2.10^5. A significantly non-uniform distribution of heat transfer coefficients over the tube periphery has been observed. Difference between temperatures on the upper and lower surfaces of the stainless steel channel wall was found to reach 9°K. It was also noted that the highest temperature on the wall outer surface is displayed from its uppermost point. Measurements of local flow temperatures revealed vortical structure of the flow. The displacement of the point with the highest temperature is attributable to the effect of vortices. The relationships for calculating local and averaged coefficients of heat transfer are also proposed.

NUCLEAR POWER PLANTS

2971 (DOE/ET—0030/3(79)) **US central station nuclear electric generating units: significant milestones.** (Department of Energy, Washington, DC (USA). Office of Nuclear Energy Programs). Sep 1979. 43p. Dep. NTIS, PC A03/MF A01.

Listings of US nuclear power plants include significant dates, reactor type, owners, and net generating capacity. Listings are made by state, region, and utility. Tabulations of status, schedules, and orders are also presented.

2972 (P—5930) **International nuclear service centers: a bibliography.** Petty, G.M.; Yokota, M. (RAND Corp., Santa Monica, CA (USA)). Mar 1978. 19p. Rand Corp., Publications Dept., 1700 Main Street, Santa Monica, CA.

The literature relating specifically to international nuclear fuel service centers would appear to be relatively scarce, based on the results of searches of the Energy Data Base, the libraries of the University of California at Los Angeles, and The Rand Corporation, and other sources. Works specifically relating to international service centers are annotated in this bibliography. Also listed, without annotation, are studies of various kinds of multinational public enterprises. In addition, there are references to many of the studies of the one-nation nuclear energy center concept. Most of these resulted from the survey of possible sites for these centers mandated by the US Energy Reorganization Act of 1974.

POWER REACTORS, NON-BREEDING, LIGHT-WATER MODERATED, BOILING WATER COOLED

REFER ALSO TO CITATION(S) 3037, 3043, 3053, 3054, 3057, 3058, 3064, 3066, 3071, 3072, 3076, 3078, 3334

2973 (COO—4066-12) **Fuel Performance Improvement Program. Quarterly progress report, April-June 1979.** Crouthamel, C.E. (comp.). (Exxon Nuclear Co., Inc., Richland, WA (USA)). Jul 1979. Contract EY-76-C-02-4066; EY-76-C-06-1830. 86p. Dep. NTIS, PC A05/MF A01.

Two series of test rods are under irradiation in the Halden Boiling Water Reactor (HBWR Series H-1 and Series H-4). Fuel rods for Series H-2 and H-3 have been fabricated and delivered to Halden. Plans for the first series of demonstration fuel assemblies for irradiation in the Big Rock Point Reactor have been modified to substitute two BRPR Series S-2 assemblies containing segmented rods, some with sphere-pac fuel, for Series S-1 assemblies that will be irradiated later. These assemblies are in the current BRPR reload and reactor startup is scheduled for September-October. An effective method for applying graphite coating to the inside surface of cladding tubes has been demonstrated. Rod loading procedures for sphere-pac fuel that assure a uniform axial fuel density have been developed. Special hardware has been designed and tested that assures the spherical fuel can be retained in the fuel column during loading and handling operations. The measured centerline fuel temperature in the pressurized sphere-pac fuel rod (HBWR Series H-4) is lower ($\sim 145^{\circ}$C) than for the reference pellet fuel rod operating at comparable linear heat ratings.

2974 (GEAP—24158) **Preliminary design handbook for flow-induced vibration of light water reactors.** Ananthanarayanan, K.S. (General Electric Co., San Jose, CA (USA). Nuclear Energy Engineering Div.). Nov 1978. Contract EN-77-C-02-4175. 136p. Dep. NTIS, PC A07/MF A01.

The various methods of assessing flow-induced vibration designs of light water reactor components are presented.

2975 (NUREG/CR—1069) **Eddy-current inspection for steam generator tubing program. Quarterly progress report for period ending June 30, 1979.** Dodd, C.V.; Deeds, W.E.; McClung, R.W. (Oak Ridge National Lab., TN (USA)). Oct 1979. Contract W-7405-ENG-26. 12p. (ORNL/NUREG/TM—353). Dep. NTIS, PC A02/MF A01.

Eddy-current methods provide the best in-service inspection of steam generator tubing, but present techniques can produce ambiguity because of the many independent variables that affect the signals. The current development program has used mathematical models and developed or modified computer programs to design optimum probes, instrumentation, and techniques for multifrequency, multiproperty examinations. Interactive calculations and experimental measurements have been made with the use of modular eddy-current instrumentation and a minicomputer. These establish the coefficients for the complex equations that define the values of the desired properties (and the attainable accuracy) despite changes in other significant variables. The computer programs for calculating the accuracy with which various properties can be measured indicate that the tubing wall thickness and the defect size can be measured much more accurately than is currently required, even when other properties are varying. Experimental measurements have confirmed these results, though more testing is needed for all the different combinations of cases and different types of defects. Design and construction of instrumentation systems that will be used in the field is continuing.

POWER REACTORS, NON-BREEDING, LIGHT-WATER MODERATED, NON-BOILING WATER COOLED

REFER ALSO TO CITATION(S) 2974, 2975, 3037, 3043, 3044, 3045, 3046, 3053, 3054, 3055, 3056, 3057, 3059, 3059, 3062, 3063, 3064, 3065, 3066, 3070, 3072, 3074, 3079, 3080, 3334

2976 (EPRI-NP—1162) **Analysis of single- and two-phase flow fields around PWR steam generator tube support plates.** Stewart, C.W.; Thurgood, M.J.; Mayer, D.W. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Aug 1979. Contract EY-76-C-06-1830. 78p. Dep. NTIS, PC A05/MF A01.

The thermal-hydraulic analysis of the Westinghouse Series 51 U-tube PWR steam generator using a newly developed two-fluid (UVUT) two-phase flow model is presented. The development of the model and current state of its constitutive modeling is described in detail and some initial data comparisons are presented. The two-fluid model was incorporated into the Battelle COBRA-IV code and the resulting developmental version is referred to as COBRA-TF (EPRI). The analysis of the Westinghouse steam generator concentrated on the local flow field a few inches above and below the tube support plates at various levels. A full-scale simulation of the entire steam generator was also performed to provide boundary conditions for the local analyses. Plots of the predicted vapor friction and velocity fields are presented for both simulations.

2977 (LRC—5193) **Rod and bundle assembly program. Final report. Remote rod and bundle assembly and inspection: preliminary design study.** Wrona, B.J. Harrison, J.L.; Holaday, V.D.; Shipman, G.A. (Babcock and Wilcox Co., Alliance, OH (USA). Research Center). May 1979. Contract EY-76-C-06-1830. 61p. Dep. NTIS, PC A04/MF A01.

The project described is a part of a FRAD program and focuses on a specific area of the required refabrication process technology. The objective of the present project is to perform a preliminary design study of rod and bundle assembly and inspection of ThO_2-UO_2 Mixed Oxide (ThoMOX) fuels that are mainly gamma emitting. Fully remote operation is assumed due to the high level of radioactivity. The present preliminary design study specifies a 17 x 17 fuel assembly for a reference design basis. However, the final system will have generic capabilities so that with limited modifications, various other fuel bundle arrays will be able to be assembled.

POWER REACTORS, NON-BREEDING, GRAPHITE MODERATED

REFER ALSO TO CITATION(S) 3061, 3064, 3108, 3175, 3336, 3337, 3391

2978 (GA-A—13990) **Cesium transport data for HTGR systems.** Myers, B.F.; Bell, W.E. (General Atomic Co., San Diego, CA (USA)). Sep 1979. Contract ET03-76ET35300. 143p. Dep. NTIS, PC A07/MF A01.

Cesium transport data on the release of cesium from HTGR fuel elements are reviewed and discussed. The data available through 1976 are treated. Equations, parameters, and associated variances describing the data are presented. The equations and parameters are in forms suitable for use in computer codes used to calculate the release of metallic fission products from HTGR fuel elements into the primary circuit. The data cover the following processes: (1) diffusion of cesium in fuel kernels and pyrocarbon, (2) sorption of cesium on fuel rod matrix material and on graphite, and (3) migration of cesium in graphite. The data are being confirmed and extended through work in progress.

2979 (GA-A—15437) **Characterization of large ceramic billets for core support and thermal insulaton in the HTGR.** Sheehan, J.E. (General Atomic Co., San Diego, CA (USA)). Aug 1979. Contract AT03-76ET35300. 184p. Dep. NTIS, PC A09/MF A01.

Full-size HTGR core-support pads of commercially available Al_2O_3, Si_3N_4 and fused SiO_2 were evaluated with respect to properties important for structural integrity. Work included microstructure, density ahd chemical characterizations and strength and creep tests on specimens removed from the pads. The materials consisted of two hot-pressed and two pressed and sintered Al_2O_3 products, a hot-

pressed Si_3N_4 and three slip-cast and sinter fused SiO_2 full-size pads. A fused-cast Al_2O_3 in brick form was also characterized.

2980 (ORNL—5582) **US/FRG joint report on the pebble bed high temperature reactor resource conservation potential and associated fuel cycle costs.** Teuchert, E.; Ruetten, H.J.; Worley, B.A.; Vondy, D.R. (Oak Ridge National Lab., TN (USA)). Nov 1979. Contract W-7405-ENG-26. 27p. Dep. NTIS, PC A03/MF A01.

Independent analyses at ORNL and KFA have led to the general conclusion that the flexibility in design and operation of a high-temperature gas-cooled pebble-bed reactor (PBR) can result in favorable ore utilization and fuel costs in comparison with other reactor types, in particular, with light-water reactors (LWRs). Fuel reprocessign and recycle show considerable promise for reducing ore consumption, and even the PBR throwaway cycle is competitive with fuel recycle in an LWR. The best performance results from the use of highly enriched fuel. Proliferation-resistant measures can be taken using medium-enriched fuel at a modest ore penalty, while use of low-enriched fuel would incur further ore penalty. Breeding is possible but net generation of fuel at a significant rate would be expensive, becoming more feasible as ore costs increase substantially. The ^{233}U inventory for a breeder could be produced by prebreeders using ^{235}U fuel.

POWER REACTORS, NON-BREEDING, OTHERWISE MODERATED OR UNMODERATED

2981 (ER—77-2, pp 15-18) **Canadian nuclear program - present status.** Aikin, A.M. (Atomic Energy of Canada Ltd., Ottawa, Ontario). [nd].

In Nuclear option for Canada. The renewable energy resources.

The performance and cost of CANDU reactors operating in Canada are briefly outlined and their significance to the Canadian energy scene noted.

2982 (ER—77-2, pp 19-25) **CANDU - future potential.** Mooradian, A.J. (Atomic Energy of Canada Ltd., Chalk River, Ontario. Chalk River Nuclear Labs.). [nd].

In Nuclear option for Canada. The renewable energy resources.

An argument is made that thorium cycle in CANDU reactors is a fuel-extending ploy superior to the commercialization of LMFBR's.

POWER REACTORS, BREEDING

REFER ALSO TO CITATION(S) 3036, 3038, 3040, 3042, 3047, 3048, 3050, 3051, 3052, 3060, 3064, 3067, 3073, 3075, 3081, 3175, 3336, 3337, 3356, 3375, 3515

2983 (CONF-791205—3) **Techniques for the thermal/hydraulic analysis of LMFBR check valves.** Cho, S.M.; Kane, R.S. (Foster Wheeler Energy Corp., Livingston, NJ (USA); Manhattan Coll., Riverdale, NY (USA). Dept. of Mechanical Engineering). 1979. Contract EY-76-C-15-2395. 25p. Dep. NTIS, PC A02/MF A01.

From ASME winter annual meeting; New York, NY, USA (2 Dec 1979).

A thermal/hydraulic analysis of the check valves in liquid sodium service for LMFBR plants is required to provide temperature data for thermal stress analysis of the valves for specified transient conditions. Because of the complex three-dimensional flow pattern within the valve, the heat transfer analysis techniques for less complicated shapes could not be used. This paper discusses the thermal analysis techniques used to assure that the valve stress analysis is conservative. These techniques include a method for evaluating the recirculating flow patterns and for selecting appropriately conservative heat transfer correlations in various regions of the valve.

2984 (DOE/TIC—10224) **Large liquid metal fast breeder reactor Intermediate Heat Exchanger maintenance study report.** Johnson, R.H. (Foster Wheeler Corp., Livingston, NJ (USA)). 8 Dec 1977. Contract W-31-109-ENG-38. 38p. AT.

Current designs for Intermediate Heat Exchangers (IHX) planned for use in Commercial LMFBR systems call for a straight tube configuration without a central downcomer. The maintenance of such a unit involves three (3) major operations: detection of leaking tubes; location of defective tubes; and plugging of leaking tubes. Two of the main objectives of this study were to investigate IHX maintainability in the areas of tube leak detection and tube plugging.

2985 (ETEC-TDR—79-6) **Evaluation of SPTF liquid rheostat for ISIP test program.** Baker, R.S. (Energy Technology Engineering Center, Canoga Park, CA (USA)). 22 Aug 1979. Contract EY-76-C-03-0700. 8p. AT.

This report is an evaluation of the performance of the liquid rheostat installed at SPTF for sodium pump speed control.

2986 (GA-A—15529) **Gas-cooled fast breeder reactor. Quarterly progress report, May 1-July 31, 1979.** (General Atomic Co., San Diego, CA (USA)). Aug 1979. Contract AT03-76SF71023. 247p. Dep. NTIS, PC A11/MF A01.

The tasks of the gas-cooled fast breeder reactor (GCFR) program that are supported by the Department of Energy include development of GCFR fuel, blanket, and control assemblies; development of the pressure equalization system for GCFR fuel; out-of-pile loop facility test programs; fuels and materials development; fuel, blanket, and control rod analyses and development; nuclear analysis and reactor physics for GCFR core design; shielding requirements for the GCFR; reactor engineering to assess the thermal, hydraulic, and structural performance of the core and the core support structure; plant systems control; systems engineering; development of reactor components, including reactor vessel, control and locking mechanisms, fuel handling equipment, core support structure, shielding assemblies, main helium circulator, steam generator, circulator test facility, and auxiliary circulator; development of a helium circulator test facility; reactor safety, environment, and risk analyses, including planning and support of an in-pile and out-of-pile safety test program; nuclear island engineering design; and development of a reliability data bank.

2987 (GEFR—00404) **Cladding component chemical transport in mixed-oxide fast reactor fuel pins: an additional (high burnup) mechanism for fuel cladding chemical interaction.** Adamson, M.G.; Aitken, E.A. (General Electric Co., Sunnyvale, CA (USA). Advanced Reactor Systems Dept.). 19 Sep 1978. Contract EY-76-C-03-0893-031. 52p. AT.

Transport of the principal metallic components of Fe-Cr-Ni austenitic cladding alloys into the fuel phase of irradiated oxide fuel pin has been reported periodically since the inception of fuel pin testing in the Fast Reactor Development Program, however, thus far, an adequate explanation for this phenomenon has been lacking. In this document we review available in-pile evidence for cladding component transport in oxide pins, delineate the major variables that appear to be responsible for its occurrence, outline the development of a working physicochemical model for cladding component chemical transport (CCCT) at moderate to high burnups, and describe how such a model may be applied in the calculation of cladding wastage due to component transport. The basis of the CCCT mechanism for FCCI is a liquid Cs,Te fission product medium in the fuel-cladding gap in which Fe, Cr, Ni, Mn, etc., can dissolve and undergo transport up the steep (radial) temperature gradient. Special requirements on the quantities of Te (and Cs) fission products present in the gap explain why CCCT is generally observed only at moderate to high burnups, and characteristic morphological features of CCCT are consistent with a dissolution-type mechanism. The thermodynamic basis of the CCCT model is also treated in some detail, and it is shown, for example, how oxygen activity influences the equilibria between tellurium and dissolved cladding components in the Cs,Te fission product melt. A preliminary quantitative analysis of recent in-pile data is performed and the results used to derive coefficients for some of the key parameters in the rate model. Finally, the model is applied to a long, commercial LMFBR-type fuel pin to illustrate the expected important contribution of CCCT to FCCI-induced cladding inner surface wastage at high burnup.

2988 (GEFR—00463) **State-of-the-art water chemistry of steam generators with emphasis on CRBRP specifications.** Simpson, J.L.; Dutina, D.; Robles, M.N.; Spalaris, C.N. (General Electric Co., Sunnyvale, CA (USA). Advanced Reactor Systems Dept.). Jun 1979. Contract EY-76-C-03-0893-030. 62p. AT.

This report is an Addendum to Reference 1, presenting an update of the CRBRP water chemistry specifications, as well as the supporting data and discussion for the changes made. Experimental data are presented from three tests conducted by General Electric. A resolution was obtained to relate water chemistry and the occurrence of DNB in the evaporator tubes for exposures up to 8,000 hours. Verification of on-line sodium ion measurement in the subppM range was provided by experiments which were necessary to solidify the CRBRP chemistry specifications. CRBRP water specifications were demonstrated in a prototypical experiment.

2989 (HEDL-S/A—1552-FP) **Fission gas behavior in mixed-oxide fuel during overpower and thermal transient tests.** Randklev, E.H.; Hinman, C.A. (Hanford Engineering Development Lab., Richland, WA (USA)). 1 Nov 1978. Contract EY-76-C-14-2170. 25p. (CONF-790306—24). Dep. NTIS, PC A02/MF A01.

From International conference on fast breeder reactor performance; Monterey, CA, USA (5 Mar 1979).

Results are presented from two complementary Hanford Engineering Development Laboratory (HEDL) programs which are investigating fission gas behavior in irradiated mixed-oxide fuel. The

combined purpose of these programs is to define steady-state and transient fission gas behavior at axial fuel pin positions as a function temperature, radial and microstructural position and mechanisms of transient gas release. The following discussion, unless otherwise noted, applies to fuel irradiated at powers from ~ 20 kW/m to ~ 40 kW/m and for burnups of ~ 40 to ~ 60 MWd/kg.

2990 (HEDL-SA—1751) **Seismic design and development for fast reactors: a design-application perspective with directions for improvement.** Severud, L.K. (Hanford Engineering Development Lab., Richland, WA (USA)). 19 Jul 1979. Contract EY-76-C-14-2170. 29p. (CONF-790816—64). Dep. NTIS, PC A03/MF A01.

From International meeting on fast reactor safety technology; Seattle, WA, USA (19 Aug 1979).

Applications of seismic design criteria and qualification methods to the US breeder reactor projects have developed new findings, improvements in design methods, and identified areas for further development. Discussions are presented regarding site free field motion, soil-structure interaction, equipment response spectra, piping, snubbers and support design analyses, dynamic decoupling, seismic qualification testing, and protection of Seismic Category I components from Non-Category I equipment failures.

2991 (HEDL-TME—79-25) **Sodium technology. Progress report, April-June 1979.** Atwood, J.M. (comp.). (Hanford Engineering Development Lab., Richland, WA (USA)). Sep 1979. Contract EY-76-C-14-2170. 55p. AT.

This report presents a quarterly summary of progress made at Westinghouse Hanford Company in the areas of radioactivity control technology and sodium systems technology.

2992 **Corrosion of 2 1/4 Cr-1Mo steel under superheat transfer conditions.** Griess, J.C.; Devan, J.H. (Oak Ridge National Lab., TN (USA)); Hampton, L.V.; Challenger, K.D. (General Electric Corporation, USA). pp 367-270 of Ferritic steels for fast reactor steam generators. Pugh, S.F.; Little, E.A. (UKAEA, Harwell. Atomic Energy Research Establishment) (eds.). London; British Nuclear Energy Society (1978).

From British Nuclear Energy Society conference on ferritic steels for fast reactor steam generators; London, UK (30 May 1977).

Steam generators being developed for use with liquid metal fast breeder reactors (LMFBR's) will operate at substantially greater heat fluxes than conventional fossil-fired steam plants. To establish the corrosion allowance for the superheater tube walls, tests on 2 1/4Cr-1Mo steel with a heat flux of 126 kW/m_0 across the specimen surface were conducted under steam conditions similar to those that will exist in LMFBR superheaters.

2993 **Mechanical properties of transition joint materials in support of LMFBR steam generator design.** Brinkman, C.R.; King, J.F.; Strizak, J.P.; Klueh, R.L.; Booker, M.K. (Oak Ridge National Lab., TN (USA)). pp 496-503 of Ferritic steels for fast reactor steam generators. Pugh, S.F.; Little, E.A. (UKAEA, Harwell. Atomic Energy Research Establishment) (eds.). London; British Nuclear Energy Society (1978).

From British Nuclear Energy Society conference on ferritic steels for fast reactor steam generators; London, UK (30 May 1977).

Mechanical data needs are identified for transition joint weldments between austenitic and ferritic structural materials planned for LMFBR service. Since the heat-affected zone in the ferritic material is apparently the critical area, particular attention must be given to behaviour in this region. Interim results are given to show differences in mechanical properties of the joint materials with particular emphasis on the ferritic materials.

2994 (ORNL/Sub—7644/10) **Research in remote signal transmission electronics.** Kennedy, E.J.; Blalock, T.V.; Phelps, J.; Rochelle, R.; Dyer, F. (Tennessee Univ., Knoxville (USA). Dept. of Electrical Engineering). 1 Oct 1979. Contract W-7405-ENG-26. 89p. (TR-EE/EL—10). Dep. NTIS, PC A05/MF A01.

Research has been directed toward the evaluation of semiconductor circuits suitable for operation at temperatures of 250°C to 300°C. These circuits are to be utilized in monitoring neutron flux in a breeder reactor. Worst-case performance evaluations are made on an amplifier-discriminator circuit utilizing commercially available operational amplifier chips incorporated in a hybrid thick-film package, which is suitable for use to 250°C. Another hybrid thick-film amplifier-discriminator system was developed and tested for use to 300°C. A dc-dc converter to supply +10v and -10v for amplifier power was designed, and evaluated up to an operating temperature of 300°C. Detailed design theory equations for high temperature dc-dc converters are presented. Significant problems with ceramic capacitors utilized at 300°C were found.

POWER REACTORS, AUXILIARY, MOBILE, PACKAGE, AND TRANSPORTABLE

2995 (LA—7858) **Selection of power plant elements for future reactor space electric power systems.** Buden, D.; Bennett, G.A.; Copper, K. (Los Alamos Scientific Lab., NM (USA)). Sep 1979. Contract W-7405-ENG-36. 354p. Dep. NTIS, PC A16/MF A01.

Various types of reactor designs, electric power conversion equipment, and reject-heat systems to be used in nuclear reactor power plants for future space missions were studied. The designs included gas-cooled, liquid-cooled, and heat-pipe reactors. For the power converters, passive types such as thermoelectric and thermionic converters and dynamic types such as Brayton, potassium Rankine, and Stirling cycles were considered. For the radiators, heat pipes for transfer and radiating surface, pumped fluid for heat transfer with fins as the radiating surface, and pumped fluid for heat transfer with heat pipes as the radiating surface were considered. After careful consideration of weights, sizes, reliabilities, safety, and development cost and time, a heat-pipe reactor design, thermoelectric converters, and a heat-pipe radiator for an experimental program were selected.

2996 (LA-UR—79-2516) **100-kW/sub e/ Nuclear space electric power source.** Buden, D. (Los Alamos Scientific Lab., NM (USA)). 1979. Contract W-7405-ENG-36. 8p. (CONF-791046—1). Dep. NTIS, PC A02/MF A01.

From 14. Princeton/AIAA/DLGR international electric propulsion conference; Princeton, NJ, USA (30 Oct 1979).

The current 100-kW/sub e/ space nuclear power technology program could provide an electric power source for nuclear electric propulsion. The power plant is relatively compact, light weight, and has the advantages of long life and immunity to degradation while passing through the Van Allen belts. The reactor is a unique design using heat pipes to transfer heat from the reactor core to the thermoelectric converters. The converters are an improved design over those used in the radioisotope space program. The radiator, used to eliminate waste heat to space, also makes use of heat pipes. All single failure points have been eliminated from the power plant design and redundancies are provided to ensure high reliability. The power plant configuration and some key results of the current component experimental program are discussed.

REGULATION AND LICENSING

REFER ALSO TO CITATION(S) 3182

ECONOMICS

2997 (LA—8019-MS) **Economic analysis of nuclear power reactor dissemination to less developed nations with implications for nuclear proliferation.** Gustavson, R.L.; Howard, J.S. II. (Los Alamos Scientific Lab., NM (USA)). Sep 1979. Contract W-7405-ENG-36. 36p. Dep. NTIS, PC A03/MF A01.

We have applied an economic model to the transfer of nuclear-power reactors from industrialized nations to the less developed nations. The model includes demand and supply factors and predicts the success of US nonproliferation positions and policies. We conclude that economic forces dominate the transfer of power reactors to less developed nations. Our study shows that attempts to either restrict or promote the spread of nuclear-power technology by ignoring natural economic incentives would have only limited effect. If US policy is too restrictive, less developed nations will seek other suppliers and thereby lower US Influence substantially. Allowing less developed nations to develop nuclear-power technology as dictated by economic forces will result in a modest rate of transfer that should comply with nuclear-proliferation objectives.

2998 (ORNL—5580) **PREMOR: a point reactor exposure model computer code for survey analysis of power plant performance.** Vondy, D.R. (Oak Ridge National Lab., TN (USA)). Oct 1979. Contract W-7405-ENG-26. 110p. Dep. NTIS, PC A06/MF A01.

The PREMOR computer code was written to exploit a simple, two-group point nuclear reactor power plant model for survey analysis. Up to thirteen actinides, fourteen fission products, and one lumped absorber nuclide density are followed over a reactor history. Successive feed batches are accounted for with provision for from one to twenty batches resident. The effect of exposure of each of the batches to the same neutron flux is determined.

CONSTRUCTION AND OPERATION

2999 (DOE/TIC—10259) **UPDATE: Nuclear Power Program information and data, July-August 1979.** (Department of Energy,

Washington, DC (USA). Div. of Nuclear Power Development). 1979. 151p. Dep. NTIS, PC A08/MF A01.

UPDATE is published every two months by the Division of Nuclear Power Development to provide a quick reference source on the current status of nuclear power plant construction and operation in the United States, and for information on the economics, fuel requirements and performance of nuclear generating units. Similar information is included on other means of electric generation as they relate to nuclear power.

FUEL CYCLE

REFER ALSO TO CITATION(S) 2980

3000 (DOE/EIA/8589—1) **Levelized Nuclear Fuel Cycle Cost Program user's guide.** (Orkand Corp., Silver Spring, MD (USA)). 28 Jul 1978. Contract EM-77-C-01-8589. 42p. Dep. NTIS, PC A03/MF A01.

This report describes the Nuclear Analysis Division's Levelized Nuclear Fuel Cycle Cost Program. An emphasis is placed upon the description of the program, operation procedures, the interactive organization of the variable inputs, output reports and user procedures. Examples of the program execution are included to assist potential users in understanding the procedures required to exercise the model.

PROCESS HEAT REACTORS

3001 **Transition joint welding development for LMFBR steam generators.** King, J.F.; Slaughter, G.M. (Oak Ridge National Lab., TN (USA)); Sullivan, M.D. (General Electric Co., San Jose, CA (USA)). pp 476-480 of Ferritic steels for fast reactor steam generators. Pugh, S.F.; Little, E.A. (UKAEA, Harwell. Atomic Energy Research Establishment) (eds.). London; British Nuclear Energy Society (1978).

From British Nuclear Energy Society conference on ferritic steels for fast reactor steam generators; London, UK (30 May 1977).

The objective of this study was to develop an improved transition weld joint between stainless steel and ferritic steel piping to circumvent the failures and concerns with joints made by existing technology. The primary concern of mismatch in coefficients of thermal expansion between the ferritic and austenitic steels and the high stresses it imposes at the interface between ferritic steel and weld metal led to an extensive elastic stress analysis involving base metal combinations, filler metals, and weld joint geometries. This analysis indicated that for pipe, stress imposed at the joint could be reduced considerably by using a transition material with an intermediate coefficient of thermal expansion between the 2 1/4Cr-1Mo ferritic steel and the austenitic stainles steel. Alloy 800H was selected as an appropriate intermediate material for this application. The advantage of using this material and the welding development involved in making these joints is described.

NUCLEAR REACTOR TECHNOLOGY

THEORY AND CALCULATION

REFER ALSO TO CITATION(S) 3811, 3851

3002 (CONF-790974—1) **Uncertainties and biases arising from methods approximations: the calculation of reaction rates in the PCA 8/7 configuration.** Maerker, R.E.; Wagschal, J.J. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 18p. Dep. NTIS, PC A02/MF A01.

From Specialists meeting on accuracies in correlation between property change and exposure data from reactor pressure vessel steel irradiations; Julich, F.R. Germany (24 Sep 1979).

In the determination of the energy spectrum of the neutron fluxes at the surveillance and 1/4 T positions of LWRs by analyzing measured reaction rates, a calculation of these fluxes is both useful and informative in guiding the unfolding, regardless of the particular unfolding procedure used. It should thus be an important part of any unfolding procedure to be able to calculate not only the fluxes but also to estimate both the corrections to this calculation arising from various methods approximations and the uncertainties in these corrections. In at least one unfolding procedure, that utilizing a generalized least squares technique, knowledge of all uncertainties including those arising from calculational methods approximations is an essential part of the input. The particular problem addressed in this paper is the estimation of some correction factors (i.e., biases or bias factors) and their uncertainties arising from various approximations used in calculating the fluxes and reaction rates in the Pool Critical Assembly (PCA) at Oak Ridge for the 8/7 configuration. In addition, the uncertainties in the calculated fluxes and reaction rates arising as the result of uncertainties in the non-nuclear data input was investigated.

3003 (HEDL-SA—1762-S) **SSTR dosimetry in critical mass measurements.** Lippincott, E.P.; Gold, R.; Ruddy, F.H.; Long, C.L.; Roberts, J.H. (Hanford Engineering Development Lab., Richland, WA (USA)). Jan 1979. Contract EY-76-C-14-2170. 6p. (CONF-790602—84(Summ.)). Dep. NTIS, PC A02/MF A01.

From ANS annual meeting; Atlanta, GA, USA (3 Jun 1979).

As part of the Advanced Fuel Recycle Program, critical mass measurements have been made of several lattices consisting of mixed oxide (PuO_2-UO_2) fuel pin in water. In addition to providing a reliable technological basis for nuclear criticality control, these measurements are designed to provide benchmark data for validation of cross sections and calculational techniques used for mixed plutonium and uranium systems. In order to characterize some of the lattices more thoroughly, spatial fission rate distributions were measured using solid state track recorders (SSTR). These fission rate traverses cannot only be compared with calculated shapes, but since SSTR observations provide absolute fission rates, the data were also used as input to the multiple-foil unfolding code, SAND-II, to derive adjusted neutron spectra. The extremely high sensitivity of the SSTR method affords in-situ dosimetry for critical mass measurements with negligible spatial and spectral perturbations.

3004 (LA—7961-MS) **FISPRO: a simplified computer program for general fission product formation and decay calculations.** Jiacoletti, R.J.; Bailey, P.G. (Los Alamos Scientific Lab., NM (USA)). Aug 1979. Contract W-7405-ENG-36. 48p. Dep. NTIS, PC A03/MF A01.

This report describes a computer program that solves a general form of the fission product formation and decay equations over given time steps for arbitrary decay chains composed of up to three nuclides. All fission product data and operational history data are input through user-defined input files. The program is very useful in the calculation of fission product activities of specific nuclides for various reactor operational histories and accident consequence calculations.

COMPONENTS AND ACCESSORIES

REFER ALSO TO CITATION(S) 3317, 3341, 3362, 3363, 3364, 3365, 3366, 3367, 3372, 3382, 3609

3005 (BNL-NUREG—26789) **Condensation induced water hammer in steam generators.** Jones, O.C. Jr.; Saha, P.; Wu, B.J.C.; Ginsberg, T. (Brookhaven National Lab., Upton, NY (USA)). Jun 1979. Contract EY-76-C-02-0016. 19p. (CONF-790888—1). Dep. NTIS, PC A02/MF A01.

From US-Japan seminar on two-phase flow dynamics; Tokyo, Japan (1 Aug 1979).

The case of condensation induced water hammer in nuclear steam generators is summarized, including both feed ring-type and economizer-type geometries. A slug impact model is described and used to demonstrate the parametric dependence of the impact pressures on heat transfer rates, initial pressures, and relative initial slug and void lengths. The results of the parametric study are related also to the economizer geometry and a suggested alternative model is presented. The importance of concerns regarding attenuation of shocks in two-phase media is delineated, and a simple experiment is described which was used to determine negligible attenuation within the accuracy of the experiment for void fractions up to over 30% in bubbly and slug flows.

3006 (CONF-790615—14) **Experimental study of gap and thickness influence on the vibration response and damping of flexible fluid-coupled coaxial cylinders.** Chu, M.; Brown, S.; Lieb, B.; Lestingi, J. (Akron Univ., OH (USA); Babcock and Wilcox Co., Akron, OH (USA); General Motors Inst., Flint, MI (USA)). 1979. Contract EY-76-C-15-2395. 52p. Dep. NTIS, PC A04/MF A01.

From 3. US national congress on pressure vessels and piping; San Francisco, CA, USA (25 Jun 1979).

Analytical capabilities for fluid-solid situations are in the process of being developed. However, since the overall phenomenon of fluid-solid interaction is not thoroughly understood, it was the objective of this study to develop and carry out an experimental program which would provide additional insight into the mechanics of fluid-solid interaction. Since one of the primary components in a nuclear power system is the reactor vessel and the thermal liner, the experimental study described in this work was limited to the response of a set of coaxial cylinders with water in the annulus. The effects of cylinder thickness and the fluid filled annulus gap size on the resonant frequencies and mode shapes of the cylinders are presented; also included is an evaluation of damping for selected

gaps and cylinder thicknesses. Details of the experimental setup and procedures are also outlined.

3007 (CONF-790966—1) **Acoustic emission monitoring of steel and concrete structural elements with particular reference to primary nuclear containment structures.** Naus, D.J. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 38p. Dep. NTIS, PC A03/MF A01.

From International conference on acoustic emission; Anaheim, CA, USA (10 Sep 1979).

Primary containments for nuclear reactors are either thick-walled steel pressure vessels (pressurized water reactors) or massive prestressed concrete structures (gas-cooled reactors). The ability to detect and analyze flaws in these structures is important for ensuring structural integrity throughout their 30 to 40 year design life. Relatively recent advancements in nondestructive testing utilizing acoustic emission (AE) have made it a potentially viable technique for in-service monitoring of the structural integrity of primary containment structures. To provide background for an assessment of the capability of AE to monitor the structural integrity of primary nuclear containments, intermediate pressure vessels tested under the Heavy-Section Steel Technology (HSST) Program and relatively simple concrete structures have been monitored by AE while under test. The results of this monitoring program are discussed.

3008 (INIS-mf—4950, pp 194-211) **Studies of radiation damages in solids with a computer simulation method.** Avramenko, V.I.; Kapinos, V.G.; Kevorkyan, Yu.R.; Kolomytkin, V.V.; Krasnoshtanov, V.F.; Platonov, P.A. 1978. (In Russian).

From Conference on reactor materials science; Alushta, Ukrainian SSR (29 May 1978).

The results are presented for studies of radiation damages in solids by using the method of studiation damages in solids by using the method of computer simulation. The considered problems involve the determination of fast neutron energy spectra and the atomic displacement rate in a reactor, the primary knock-on atom spectra, the investigation of atomic collision cascades and annealing processes, the motion of dislocations in the field of radiation damages, ets. The developed computer programs are charcteriized in brief, some results of computer simulation are presented.

3009 (INIS-mf—4950, pp 123-129) **Electron pressure effects in stopping of nuclear fission fragments in metals.** Borin, I.P. 1978. (In Russian).

From Conference on reactor materials science; Alushta, Ukrainian SSR (29 May 1978).

When nuclear fission fragments pass through a metal there arises a volume force determined by the electron pressure gradient. The electron pressure occurs due to the local heating of electrons when the fragment is stopped. The volume force results in the motion of the material and emergence of stresses in it. The stresses calculated under the short impact approximation are inversely proportional to the coefficient of the electron thermal diffusivity of the metal. In metals with low coefficients of the electron thermal diffusivity the stresses near the fission fragment trajectory may reach the yield strength.

3010 (INIS-mf—4950, pp 340-354) **Evolution of cascades of atom-atom collisions with primary knock-on atom energy increase.** Kirsanov, V.V. 1978. (In Russian).

From Conference on reactor materials science; Alushta, Ukrainian SSR (29 May 1978).

The evolution of cascades of atom-atom collisions with the increase of primary knock-on atom PKA energy in α-Fe is investigated with a molecular dynamics technique. The energy range studied was from 1.5 KeV up to 0.1 MeV. Besides, the effects of irradiated crystal temperature and of electron energy losses on the cascade development were taken into consideration. It was found that at high PKA energies and low temperatures a cascade appears to be a series of overlapping subcascades. The mechanism of their splitting is suggested which takes account of both the factor of PKA energy and the irradiated crystal temperature factor. The cascade splitting into several visible subregions occurs at elevated temperatures of the crystal. The origin of the splitting lies in the localization of single subcascades due to thermal vibrations of the crystal under irradiation.

3011 (INIS-mf—4950, pp 30-76) **Present status of radiation damage research in the USSR.** Zelenskii, V.F.; Ivanov, V.E.; Kazachkovskii, O.D.; Platonov, P.A.; Tsykanov, V.A. 1978. (In Russian).

From Conference on reactor materials science; Alushta, Ukrainian SSR (29 May 1978).

The USSR present status of Radiation Damage Research of Reactor materials is reviewed. The main results of theoretical and experimental studies of fundamental problems in Physics of Radiation Damage of a wide range of processes occuring in Reactor core materialts (swelling, irradiation growth, irradiation hardening and embrittlement, etc.) are presented. The problem raised by the use of charged particle accelerators to simulation and study of phenomena in materials under irradiation is discussed. Some questions concerning the organization of researches in Radiation Damage Physics are considered.

3012 (INIS-mf—4950, pp 130-152) **Standartization of methods for calculating DPA and PKA-spectra.** Slabospitskii, R.P.; Yamnitskii, V.A.; Shilyaev, B.A.; L'vov, A.N.; Migalenya, V.Ya.; Lopatko, I.D.; Chegoryan, M.A.; Timoshevskii, G.F.; Kozina, G.P.; Vaisfel'd, A.M. 1978. (In Russian).

From Conference on reactor materials science; Alushta, Ukrainian SSR (29 May 1978).

The paper discusses standartization of methods for calculating primary knock-on atoms PKA - spectra and defects per atoms DPA quantity in reactor structural materials which are induced by irradiation with neutrons, protons and heavy ions. In calculations the method of mathematical simulation for primar, particle and energetic ion trajectories was used involving also modern nuclear models (optical, pre-equilibrium statistical, radiative capture, Lindhard models) to describe nuclear interactions. Computational programs and data are organized into a system-program complex for the computer BESM-6. The program complex was used to calculate damages in structural materials (13 elements) after irradiating them with the neutrons of the EBR-11 and thermonuclear spectra, 20 MeV protons and similar heavy ions with energies of 0.2 and 1 MeV/nucleon. Different plots charaterizing the regions of DPA, PKA - spectra and other data necessary for structure calculations in solids and simulation experiments at accelerators are presented. The similarity criterion for primary knock-on atom spectra which allows to choose the type and energy of simulating particles is also presented.

3013 (ORNL/NSP-NCS—1/9-79) **Report on RDT standards to National Consensus Standards.** (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 36p. RSO.

FUEL ELEMENTS

3014 (CONF-790884—1) **Some properties for modeling of fuel elements.** Nichols, F.A. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 15p. Dep. NTIS, PC A02/MF A01.

From Post-SMiRT5 second international seminar on mathematical/mechanical modeling of reactor fuel elements; Berlin, F.R. Germany (20 Aug 1979).

Two areas key to the materials modeling of fuel element behavior are discussed. The relative importance of atomic diffusion vs. bubble migration is first surveyed and the interplay of bubble mobility and re-solution parameter is highlighted. It is concluded that biased bubble migration at higher temperatures is required to explain available gas-release data, especially during transients. At intermediate temperatures, random bubble migration is required to explain both gas-release rates and the observation of large ($\sim$ 700A) intragranular bubbles following in-pile and post-irradiation transients. Different fuel models employ different values of re-solution parameter, both below and above an experimentally determined value. Bubble mobilities are deduced to approach theoretical, surface diffusion-controlled values during transients, but they may be somewhat less mobile during steady-state operation. Next, the present understanding of radiation-induced hardening and creep is discussed, highlighting the interplay of these two phenomena. An overall constitutive scheme is presented and predictions of failure limits are deduced therefrom employing instability analysis.

3015 (GA-A—15509) **Distribution of steady state temperatures and thermoelastic stresses in a cylindrical shell with internal heat generation and cooled on both sides or only on one side.** Melese d'Hospital, G.B. (General Atomic Co., San Diego, CA (USA)). Oct 1979. Contract AT03-76ET35300. 80p. Dep. NTIS, PC A05/MF A01.

General expressions for steady state temperatures and elastic thermal stress distributions are derived for a hollow fuel element cooled on both sides. The main simplifying assumptions consist of one dimensional heat transfer and a single medium. Dimensionless numerical results are plotted in the case of uniform internal heat generation and for constant thermal conductivity. Solid rods and flat plates are treated as special cases. As could be expected, cooling on both sides rather than on only one side, leads to significant reduction in maximum fuel temperature and thermal stresses for a given power density, or to a significant increase in power density for either given maximum temperature drop in the fuel or for maximum tensile thermal stress. Typically, for a rod diameter ratio of 2, the power density could be increased by a factor of 3 to 4 without increasing the maximum stress. Similarly, for the same power density, replacing internal cooling of a hollow fuel element by external cooling reduces the maximum fuel temperature drop by a factor of 1.5 and the average fuel temperature drop (or maximum tensile stress) by a

factor of 2, with the same maximum compressive stress (for a rod O.D./I.D. of 2).

3016 Neutron radiography facility at the Hanford Engineering Development Laboratory. Jackson, C.N. Jr. (Westinghouse Hanford Co., Richland, WA); Barton, J.P.; Proudfoot, E.A. *Mater. Eval.;* **37**: No. 7, 55-61(Jun 1979).

The Hanford Engineering Development Laboratory (HEDL) Neutron Radiography Facility provides capability for critical examination of nuclear fuel and assemblies. It features a unique divergent collimator designed specifically to provide high-sensitivity radiographic images at a throughput up to 240 fuel pin images per 8-hour shift. Matching components, including collimator, vacuum cassette, and film, combined to yield the largest known neutron radiograph yet obtained in a single exposure. Performance of the collimator demonstrated that adherence to discussed concepts yields a highly satisfactory neutron beam. Neutron radiographs and measurements of the neutron beam characteristics are presented. Applications have included examination of fuel pins and assemblies for the Fast Flux Test Facility (FFTF). Future developments focus on dimensional measurements of fuel pellet diameter and three-dimensional neutron radiography.

3017 Device and method for determining the power distribution in a nuclear reactor fuel assembly. Ball, R.M. (to Electric Power Research Inst., Palo Alto, CA (USA); Deutsches Patentamt, Muenchen (Germany, F.R.)). German(FRG) Patent 2,739,485/A/. 9 Nov 1978. 16p. (In German).

The distribution and concentration of ^{140}La gives an exact recording of fission product deposition and therefore of the power distribution of a fuel assembly. Measurement is performed with an inactive system. When a certain threshold value is exceeded the γ radiation emitted by ^{140}La produces a neutron flux in a converter material consisting e.g. of D or Be. The converter material itself encloses a medium to be activated having got the shape of a wire or belt made of Au, Ag, Mn, or Lu. The spatial representation of the residual radiation will then be obtained on this activated medium. The detector itself may be designed tube-shaped or stratified. The wire or belt is analyzed by conventional means.

RADIOACTIVE EFFLUENTS

REFER ALSO TO CITATION(S) 2999

CHEMICAL AND THERMAL EFFLUENTS

REFER ALSO TO CITATION(S) 3614, 3615, 3649

RESEARCH, TEST, AND EXPERIMENTAL REACTORS

REFER ALSO TO CITATION(S) 2676, 2991, 3049, 3052, 3065, 3077

3018 (CONF-790803—45) Calibration of a drag disc turbine transducer and a gamma beam densitometer to measure the mass flow rate in separated horizontal two-phase flow. Reimann, J.; Solbrig, C.W. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Inst. fuer Reaktorbauelemente; Idaho National Engineering Lab., Idaho Falls (USA)). 1979. Contract EY-76-C-07-1570. 6p. Dep. NTIS, PC A02/MF A01.

From 14. intersociety energy conversion conference; Boston, MA, USA (5 Aug 1979).

The accurate measurement of two-phase mass flow rate is very important in experiments, such as the LOFT experiment, which investigate the hypothetical Loss-of-Coolant Accident (LOCA). This paper analyzes experiments designed to determine the behavior of a LOFT free field drag disc turbine transducer (DTT) and a LOFT-type three-beam gamma densitometer in a steady state, horizontal high pressure steam-water flow. The experiments were conducted in a mass flow and void fraction range where a variety of separated flow regimes existed which strongly influenced the performance of the DTT. It is shown that the accuracy of the instruments is mainly a function of the void fraction.

3019 (CONF-791051—1) Coupled Fast Reactivity Measurements Facility and its applications to dosimetry. Rogers, J.W. (Idaho National Engineering Lab., Idaho Falls (USA)). 1979. Contract EY-76-C-07-1570. 7p. Dep. NTIS, PC A02/MF A01.

From 3. ASTM-EURATOM symposium on reactor dosimetry; Ispra, Italy (1 Oct 1979).

The Coupled Fast Reactivity Measurements Facility (CFRMF) has been used for several years in fast neutron dosimetry studies. These studies have included the neutron energy spectrum, dosimetry cross-sections, fission product yields, dosimeter calibration and testing, fission rate measurements, detector calibrations, helium production cross-sections, flux distributions and various other integral cross-sections. The CFRMF neutron field has been established as a dosimetry benchmark neutron field and has been involved extensively in inter-laboratory reaction rate measurements testing programs. The available and reproducible neutron flux densities of up to 8.6 x 10^{11} n/cm^2/sec make it useful for dosimetry testing more closely related to power and test reactor fluences. Methods and equipment have been developed to provide the testing of dosimeters and for producing irradiated dosimeter standards. The production of these standards and the testing of dosimeters are vital to the dosimetry of test and power reactors to assure that radiation measurements are producing the correct results.

3020 (DOE/ER/10493—1) Recent developments at the TRISTAN on-line mass separator. Brenner, D.S.; Chrien, R.E.; Gill, R.; Stelts, M.; Hill, J.C.; Wohn, F.K. (Clark Univ., Worcester, MA (USA); Brookhaven National Lab., Upton, NY (USA); Ames Lab., IA (USA)). 1979. Contract AC02-79ER10493. 10p. (CONF-790976—5). Dep. NTIS, PC A02/MF A01.

From International symposium on future directions in studies of nuclei far from stability; Nashville, TN, USA (10 Sep 1979).

The installation of the mass separator TRISTAN, on-line at the Brookhaven HFBR will be reviewed with emphasis placed on recent developments.

3021 (DOE/EV—0046(Vol.2), pp 208-223) Organic Moderated Reactor Experiment decontamination and decommissioning project at the Idaho National Engineering Laboratory. Hine, R.E.; Meservey, R.H. (EG and G Idaho, Inc., Idaho Falls). Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

The Organic Moderated Reactor Experiment (OMRE) facility was designed to investigate and develop organic coolant technology and was operated at the Idaho National Engineering Laboratory (INEL) from 1957 until 1963. Following final reactor shutdown, the nuclear fuel and reactor vessel internals were removed and the organic coolant (Sanowax) was drained from all systems. The facility remained in this deactivated condition until October, 1977. At that time dismantling and removal of the facility was started. The OMRE Decontamination and Decommissioning (D and D) project involves the removal of all reactor systems, the reactor vessel, buildings, roadways, parking lots, power lines, contaminated soil, and fences. The area will then be returned to its natural state by grading and seeding with crested wheat grass. Details pertaining to management of the project, technical approaches, costs, schedules, radiation levels, waste volumes, and final disposition are presented. Photographs showing various stages of the dismantling operations are also included.

3022 (HEDL-SA—1744-FP) FFTF regulatory review for operating authorization. Schade, A.R.; Simpson, D.E. (Hanford Engineering Development Lab., Richland, WA (USA)). 1979. Contract EY-76-C-14-2170. 7p. (CONF-790816—63). Dep. NTIS, PC A02/MF A01.

From International meeting on fast reactor safety technology; Seattle, WA, USA (19 Aug 1979).

The Project has undertaken design studies of concepts capable of providing added containment safety margins. Since the events, for which these features provide consequence reductions, are beyond the design basis accident classification, the conceptual designs would not be designed as Engineered Safety Features. A final decision has not been made by the Department of Energy as to the disposition of this advice. It is the Project's plan to develop sufficient design details for these features that construction schedules and cost estimates can be formulated. This information supplemented by the continuing analytical and experimental program to assess the adequacy of FFTF containment margins will enable a decision to be made as to additional features to be added to FFTF and their schedule for implementation.

3023 (HEDL-SA—1945) Natural circulation in FFTF. Additon, S.L.; Bouchey, G.D. (Hanford Engineering Development Lab., Richland, WA (USA)). Oct 1979. Contract EY-76-C-14-2170. 40p. (CONF-791074—1). Dep. NTIS, PC A03/MF A01.

From US/USSR exchange meeting on fast reactor safety; Moscow, USSR (8 Oct 1979).

This paper provides a review of the evaluation of natural circulation in the Fast Flux Test Facility (FFTF), a loop type reactor plant. The emphasis is on the role of natural circulation in decay heat removal; however, free convection during either operation at power or normal shutdown does influence some aspects of the design and these are mentioned. In treating decay heat removal the topics discussed include steady state loop performance and transient dynamics for conditions immediately after scram and for the longer term which involves different considerations. The review summarizes complex dynamics, specific to the FFTF design evaluation, which particularly illustrate large available margins for decay heat removal (possibly involving coolant boiling). Also addressed are modelling considerations and the status of experimental programs. To date, design adequacy has been assessed largely by a

combination of component tests and system analyses, with design margins increased to accommodate uncertainties. Presently planned tests, when completed, will provide an empirical base for characterizing system dynamic behavior in the range most relevant to current LMFBR designs and will demonstrate FFTF decay heat removal capability directly.

3024 (IDO—1570-T25) **LOFT monthly progress report for August 1979.** (Idaho National Engineering Lab., Idaho Falls (USA)). Sep 1979. Contract EY-76-C-07-1570. 66p. Dep. NTIS, PC A04/MF A01.

During August, both plant and planning efforts revised the project activities to perform a series of small break and operation transient tests. That test series, shown in Chapter III of this report, consists of tests spaced six to eight weeks apart, beginning in November. Before that time, the plant will require nuclear and nonnuclear checkout as a result of fuel changes performed in July. Additionally, the efforts of operations and experimental support personnel will require reorganization to prepare for such a rapid test sequence with attendant demands for preparation and data evaluation. At the end of August, the test plan was still receiving some final evaluation to determine the need for a test around February 1980 to provide data requested by the Nuclear Regulatory Commission (NRC). Schedule progress during August toward performance of the first LOFT nuclear small break tests was good, despite electrical problems encountered. These problems are associated with all incoming commercial power, after lightning and high winds damaged some lightning arrestors and circuit breakers. Repairs have proceeded as quickly as possible, with other plant work rescheduled to accommodate supply and outage impacts. In spite of these problems, the project is slightly ahead of schedule when compared with the commitment date for the L3-1 test.

3025 (IDO—1570-T26) **LOFT monthly progress report, July 1979.** (EG and G Idaho, Inc., Idaho Falls (USA)). Aug 1979. Contract EY-76-C-07-1570. 68p. Dep. NTIS, PC A04/MF A01.

During July, the center fuel module was removed from the LOFT reactor and a new module inserted. This was the first use of the associated equipment with an irradiated fuel module. The operation was performed successfully and ahead of schedule. Inspection of the remaining fuel bundles, made possible when the center module was removed, revealed no evidence of damage or deformation. This inspection confirms earlier expectations based on measured temperatures and on the lack of fission products in the primary coolant. Thus, it appears that no fuel damage resulted from loss-of-coolant tests L2-2 and L2-3. The removed center fuel module will receive additional nondestructive hot cell examination and will be held for possible reuse in LOFT.

3026 (INIS-mf—4952, pp 58-72) **WWR-S reactor used in experimental neutron physics.** Bayer, R.; Honzatko, J.; Kvitek, J.; Mikula, P. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderne Fyziky). Sep 1977. (In Czech).

From Seminar on research and experimental reactors and their impact on the national economy; Plzen, Czechoslovakia (27 Sep 1977).

A survey is presented of basic and applied problems in solid state physics, radiative neutron capture, nuclear reactions of neutrons resulting in alpha emission and fission by neutrons which are studied on the horizontal channels of the WWR-S reactor. The SPN-100 multipurpose spectrometer of polarized neutrons and the TKSN-400 slow neutron spectrometer are installed in the reactor for the study of the dynamics of crystal and magnetic lattices of solids and the dynamics of liquids by inelastic scattering, and of dynamic effects in perfect and slightly deformed single crystals. The study of the chemical and magnetic structure of ferrites and chromites is performed on the KSN-2 two-axis crystal neutron spectrometer. Neutron physics methods are briefly described applied in the solution of various technical problems, such as reaction (n,γ) in the chemical analysis of materials, reaction (n,α) in the determination of boron and lithium, etc.

3027 (INIS-mf—4952, pp 50-57) **SR-O reactor - description and applications.** Cerny, K.; Boucek, F.; Vespalec, R.; Jirousek, V.; Jilek, M. (Skoda, Plzen (Czechoslovakia)). Sep 1977. (In Czech).

From Seminar on research and experimental reactors and their impact on the national economy; Plzen, Czechoslovakia (27 Sep 1977).

The SR-O reactor is a small tank type reactor with an output of about 2000 W. It is designed for work and measurements in applied reactor physics, for the development of measuring sensors and methods, for training nuclear power plant personnel, and as a source of intensive reactor radiation. Its core is variable depending on the requirements of the experiment, the IRTM type fuel is enriched to 80% ^{235}U. The low fuel burn-up makes possible experiments in the deep subcriticality region, which is important for the initial stage of power reactor start-up. The reactor is also used for testing control assemblies for research and experimental reactors and in the development of neutron materials testing methods.

3028 (INIS-mf—4952, pp 12-20) **Reactor WWR-S - parameters and experimental facilities.** Musilek, F.; Slechta, M. (Ustav Jaderneho Vyzkumu CSKAE, Rez (Czechoslovakia)). Sep 1977. (In Czech).

From Seminar on research and experimental reactors and their impact on the national economy; Plzen, Czechoslovakia (27 Sep 1977).

The WWR-S research reactor which has so far been the only relatively high-power research reactor in Czechoslovakia was initially used mainly for research in nuclear and reactor physics and for radioisotope production. It has now been primarily employed for reactor physics experiments. This was attained by increasing the reactor output to 10 MW by replacing the EK-10 fuel by a new IRTM fuel type. The IRTM fuel with 80% ^{235}U enrichment consists of concentric square tubes with walls 2 mm thick. The effective part of the fuel bundle consisting of four tubes is 58+-2 cm long. The reconstruction of the reactor contributed to a five-fold increase in neutron flux which is now in the order of 10^{14} n/cm^{2}s. The use of a beryllium reflector results in a neutron flux increase to $3x10^{14}$ n/cm^{2}s. The core configuration allows conducting experiments in the core middle section. The new fuel permits attaining a burn-up of 40 to 45%. Further improvement of irradiation conditions will be achieved by use of a new DORA charging machine which will provide charging irradiation capsules and their removal from the irradiation channels.

3029 (INIS-mf—4952, pp 30-36) **Radiation engineering at the WWR-S reactor.** Rypar, V.; Burian, J.; Hrdlicka, Z. (Ustav Jaderneho Vyzkumu CSKAE, Rez (Czechoslovakia)). Sep 1977. (In Czech).

From Seminar on research and experimental reactors and their impact on the national economy; Plzen, Czechoslovakia (27 Sep 1977).

Research into primary circuit modes of the WWER-440 reactors is conducted on the WWR-S research reactor at Rez using the RVS-2 medium-pressure loop having specifications 6.5 MPa, 200 degC, 2 t/h; a reactor probe with a rabbit tube for sample transport 6 mm in diameter; and a high-pressure 20 MPa, 350 degC stand for sensor technology research. The RVS-3 water loop is being built having specifications 18 MPa, 350 degC, 10 t/h which will be controlled by an ADT 4100 computer. The WWR-S reactor is also used in shielding physics research, this mainly of neutron transport through a sodium piping. The sodium piping mock-up consists of a filter and 10 measuring sections. The basic part of a measuring section essentially is a sodium core 40 cm in diameter placed in a thin-walled aluminium vessel surrounded by a steel piping 1 cm thick. A second layer 6 cm thick is either a steel thermal shielding or heat insulation of glass wool or a space. The piping is surrounded by a concrete shielding. Research in neutron radiography is conducted on the WWR-S reactor horizontal channel 100 mm in diameter in which a thermal neutron flux density of $1.12x10^{11}$ n/m^{2}s and a gamma dose rate of 10 R/h may be attained at a reactor thermal output of 6 MW.

3030 (LTR—141-122) **6-Beam test (for gamma densitometer).** Good, R.R. (Idaho National Engineering Lab., Idaho Falls (USA)). 15 Aug 1979. Contract EY-76-C-07-1570. 32p. Dep. NTIS, PC A03/MF A01.

The results are presented of a test series designed to quantify the cross talk between beams of a six-beam gamma densitometer, and to verify the accuracy of the N-beam densitometer data reduction program. The 6-beam densitometer used was designed for use in the Wyle Transient Test Program.

3031 (ORNL/TM—7087) **High flux isotope reactor. Quarterly report, April, May, and June, 1979.** Corbett, B.L.; McCord, R.V.; Poteet, K.H. (Oak Ridge National Lab., TN (USA)). Oct 1979. Contract W-7405-ENG-26. 21p. Dep. NTIS, PC A02/MF A01.

Routine reactor operation with four end-of-cycle shutdowns, one scheduled shutdown for analysis of servo problems, and one unscheduled shutdown resulted in an on-stream time of 87.4%. Scheduled reactor component replacement and the semiannual reactor component inspection were completed.

PLUTONIUM AND ISOTOPE PRODUCTION REACTORS

3032 (CONF-791103—37) **Suitability of x-ray paper as an inspection tool for flat plate nuclear fuel.** Barna, B.A. (EG and G Idaho, Inc., Idaho Falls (USA)). 1979. Contract EY-76-C-07-1570. 8p. Dep. NTIS, PC A02/MF A01.

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

The flat plate nuclear fuel used in the Advanced Test Reactor (ATR) has several attributes which are best examined by radiography. These are fuel core dimensions and location, homogeneity of the uranium aluminide alloy that composes the core, and the location

and sizing of fuel particles in the fuel free edge borders of the plates. The most economiccal approach is to inspect for all three attributes from a single radiograph which requires accommodation of a large contrast range. Currently radiography is conducted using Kodak type M double emulsion film which provides a high quality image for evaluation. A promising alternative to film exists however in paper radiography. The two media are very similar except that paper uses a single emulsion which is deposited on an opaque diffuse reflecting surface. This requires that the image be viewed with reflected rather than transmitted light. This type of physical structure results in lower materials and processing costs. For example, Kodak Industrex 600 paper is approximately 50% the cost of type M film. In addition the image can be developed and viewed (although not fixed) in as little as 10 seconds. The results of test to ascertain the suitability of paper radiography for these purposes are described. Whole there was some degradation of the image with the use of paper, the paper was judged suitable for identification of edge border location, homogeneity, and floking.

3033 (CONF-791103—38) **Automated ultrasonic scanning of flat plate nuclear fuel.** Barna, B.A. (EG and G Idaho, Inc., Idaho Falls (USA)). 1979. Contract EY-76-C-07-1570. 6p. Dep. NTIS, PC A02/MF A01.

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

One of the most challenging problems in Non-Destructive Testing lies in making the inspection as rapid, precise, cost effective and operator independent as possible. Only by optimizing these four factors can a technology take full advantage of the quality control possible with NDT. This paper describes a highly complex application of high frequency ultrasonics to image extremely small and difficult to detect flaws in a production line environment. The objects of interest are flat plate nuclear fuel used in the Advanced Test Reactor at the Idaho National Engineering Laboratory. The plates are fabricated by hot rolling a sandwich of alloyed uranium fuel and aluminum cladding. After rolling, the block is flattened to a long thin plate approximately 1.27 m (55 inches) long, 102 mm (4 inches) wide and 1.25 mm (0.050 inches) thick. The core, or fuel area is nominally 0.75 mm (0.030 inches) thick with 0.25 mm (0.010 inches) of aluminum bonded to both sides. As might be expected the fabrication is a sensitive process which can introduce several flaws detrimental to the reactor operation if they are undetected. Two of the characteristics that must be examined are the cladding thickness of the aluminum left over the fuel and the quality of bond between the cladding and the fuel. If either the cladding is too thin or the bonding inadequate thermal and/or corrosive activity can crack the protective cladding.

3034 (INIS-mf—4952, pp 21-29) **Research and production of radionuclide and radiopharmaceutical preparations.** Kronrad, L.; Svoboda, K. (Ustav Jaderneho Vyzkumu CSKAE, Rez (Czechoslovakia)). Sep 1977. (In Czech).

From Seminar on research and experimental reactors and their impact on the national economy; Plzen, Czechoslovakia (27 Sep 1977).

The number of institutions using radionuclides and radiopharmaceuticals in Czechoslovakia has constantly been growing. It is expected that by 1980 they will number 600 and the consumption of the materials will reach about 100,000 Ci. In 1980 the number of examinations using nuclear medicine techniques will approach 500,000. Currently, the reconstructed WWR-S reactor in Rez whose neutron flux is sufficient for this work is suitable for the preparation of radioactive compounds. Its irradiation possibilities are studied, however, from the point of view of sites where irradiation work may proceed. A table is shown of the WWR-S reactor irradiation possibilities at various core configurations proving that the number of irradiation sites is considerable. The reactor is also sufficient for the production of most radionuclide preparations. Also shown is the financial volume of the consumption of the most important preparations in the years 1972 to 1974 as is the estimate of economic contributions of the production of some radionuclides and radiopharmaceuticals in 1980 using the WWR-S reactor. The conclusion is arrived at that 40% to 45% of the overall consumption of radionuclide preparations might thus be secured.

PROPULSION REACTORS

3035 (DOE/EV—0046(Vol.2), pp 236-240) **Nuclear fuel recovery operations at the Nuclear Space Rocket Facility, Nevada test site.** Bromley, C.P. (Department of Energy, Las Vegas, NV). Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

Between 1959 and 1972, a total of 20 Rover and NERVA reactors were tested at the Nevada Test Site for the Nuclear Rocket Propulsion Program. Following each test the reactor was disassembled and the graphite and uranium fuel rods which contained a total of 2500 kilograms of 93% enriched uranium, were placed in storage. In addition, the Tory II-C a nuclear ram jet engine containing 59 kilograms of uranium in a beryllium oxide matrix, was tested in 1964, then stored intact for later disassembly. Upon termination of the Nuclear Rocket Propulsion Program in June 1973, it became necessary to dispose of the nuclear fuel and a program was initiated to prepare and ship the material to the INEL for later uranium recovery. The E-MAD Facility in Area 25 of the NTS was available for the remote handling operations required, and a crew of experienced people was retained to accomplish this task.

REACTOR SAFETY

3036 (ANL-AFP—55) **Advanced fuels development program. Quarterly progress report, April-June 1978.** Kittel, J.H. (comp.). (Argonne National Lab., IL (USA)). 1978. Contract W-31-109-ENG-38. 240p. AT.

Progress is summarized in the following LMFBR mixed carbide and mixed nitride fuel development tasks: steady-state irradiation performance, transient irradiation performance, fabrication, design and modeling, fuels properties, safety, and environmental assessment.

3037 (CAAP-TR—042(Rev.1)) **Code assessment and applications program.** Chapman, R.L.; Hanner, O.M. Jr.; Wells, M.E. (EG and G Idaho, Inc., Idaho Falls (USA)). Sep 1979. Contract EY-76-C-07-1570. 318p. Dep. NTIS, PC A14/MF A01.

This document presents the results of a review and evaluation of actual and potential water hammer events in both BWR and PWR power plants. Known or suspected water hammer events were reviewed and tabulated. Possible scenarios for potentially damaging water hammer occurrences in safety-related systems were developed. The effectiveness of subsystems and design features used to prevent water hammer and the potential for water hammer in certain systems due to various initiating mechanisms were also addressed. Specific recommendations on design, operational and testing criteria, and applicant/station operator requirements were made to prevent and avoid damaging water hammer in the design of future nuclear plants.

3038 (CONF-790816—59) **Molten core debris-sodium interactions: M-Series experiments.** Sowa, E.S.; Gabor, J.D.; Pavlik, J.R.; Cassulo, J.C.; Cook, C.J.; Baker, L. Jr. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 11p. Dep. NTIS, PC A02/MF A01.

From International meeting on fast reactor safety technology; Seattle, WA, USA (19 Aug 1979).

Five new kilogram-scale experiments have been carried out. Four of the experiments simulated the situation where molten core debris flows from a breached reactor vessel into a dry reactor cavity and is followed by a flow of sodium (Ex-vessel case) and one experiment simulated the flow of core debris into an existing pool of sodium (In-vessel case). The core debris was closely simulated by a thermite reaction which produced a molten mixture of UO_2, ZrO_2, and stainless steel. There was efficient fragmentation of the debris in all experiments with no explosive interactions observed.

3039 (CONF-790873—1) **Equivalent viscous damping procedure for multi-material systems.** Ahmed, H.; Ma, D. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 17p. Dep. NTIS, PC A02/MF A01.

From Post-SMIRT seminar; Brussels, Belgium (23 Aug 1979).

The inclusion of accurate viscous damping effects in the seismic analysis of nuclear power plants is discussed. A procedure to evaluate and use equivalent viscous damping coefficients in conjunction with the substructure method of finite element analysis is outlined in detail.

3040 (COO—2571-17) **Improvement and verification of fast reactor safety analysis techniques. Progress report, April 1, 1979-June 30, 1979.** Barker, D.H.; Wiberg, D.V. (Brigham Young Univ., Provo, UT (USA). Dept. of Chemical Engineering). 1979. Contract EY-76-S-02-2571. 36p. Dep. NTIS, PC A03/MF A01.

This report details a mathematical model for the dissipation of heat from an internally heated liquid pool which is contained in a hollow cylinder of finite inside and outside diameter. The model includes a temperature profile for the previously described cylinder, empirical correlations for Nusselt numbers at the walls of the container and a film theory correction of the heat transfer coefficients for mass transfer. Also included in this report is a description of the experimental work conducted as a preliminary step to verification or rejection of the proposed mathematical model. This experimental work consisted of reacting Dimethyl Sulfoxide (DMSO) with Acetyl Chloride (AC), using Acetone as a solvent, in a hollow wax cylinder and observing the geometry and dimensions of the melt.

3041 (CS-INIS—245) **Problems of nuclear power plant safety evaluation.** Suchomel, J. (Vyskumny Ustav Energeticky, Bratislava

(Czechoslovakia)). 31 Dec 1977. 83p. (In Czech). Vyskumny Ustav Energeticky, Bratislava, Czechoslovakia.

Nuclear power plant safety is discussed with regard to external effects on the containment and to the human factor. As for external effects, attention is focused on shock waves which may be due to explosions or accidents in flammable material transport and storage, to missiles, and to earthquake effects. The criteria for evaluating nuclear power plant safety in different countries are shown. Factors are discussed affecting the reliability of man with regard to his behaviour in a loss-of-coolant accident in the power plant. Different types of PWR containments and their functions are analyzed, mainly in case of accident. Views are discussed on the role of destructive accidents in the overall evaluation of fast reactor safety. Experiences are summed up gained with the operation of WWER reactors with respect to the environmental impact of the nuclear power plants.

3042 (DOE/EV—0046(Vol.2), pp 111-142) **Combustion of sodium in the open atmosphere.** Morewitz, H.A.; Johnson, R.P.; Nelson, C.T.; Otter, J.M. (Rockwell Hanford Operations, Richland, WA). Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

A series of sodium fire tests has been conducted in ambient air at a meteorological test site. This test series was designed to simulate hypothetical accidents which might occur in the heat transport system of an LMFBR. Measurements of concentration, agglomeration, fallout, and chemical species of sodium combustion products were made as a function of downwind distance. In each of the first two tests, ~ 23 kg of 540°C sodium was sprayed as a fan of 250-μm sodium drops across the wind, from heights of 5 or 6 m. Each release took a few minutes. Two additional tests were performed by releasing sodium through 9.5-mm diameter jets at a height of 30 m. In each test, the sodium jet was aimed horizontally across the wind, and followed a downward parabolic trajectory, releasing burning sodium drops along its track. In a third type of test, sodium was burned for 60 min as a pool in a 1.5 m^2 burn pan at 9 m/s wind velocity. Approximately 30% of the combustion products became airborne. Large agglomerates fell out as they moved downward, depositing 2 kg/m^2 at 1 m downwind from the edge of the pan.

3043 (DPST—77-453) **Incorporation of a steady-state restart initialization option in the MEKIN code.** (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). 29 Aug 1977. Contract EY-76-C-09-0001. 146p. Dep. NTIS, MF A01.

Portions of document are illegible.

The computer code MEKIN provides an analysis of space-dependent transients in light water reactor cores. Specifically, MEKIN models three-dimensional thermal, hydraulic, and neutronic phenomena in boiling water and pressurized water reactor cores. The code also performs the static calculations required to establish reactor initial conditions. SRL has developed a steady-state initialization procedure in MEKIN which alleviates the particular problems described above. This memorandum summarizes this steady-state initialization capability and present details of the procedure for execution of the option and a description of modifications for implementation of the option in the computer code. Examples of the use of the initialization feature are also given.

3044 (EGG-CAAP—5022) **Assessment of the RELAP4/MOD6 thermal-hydraulic transient code for PWR experimental applications. Addendum. Analyses completed and reported in FY 1979. Interim report.** (EG and G Idaho, Inc., Idaho Falls (USA)). Sep 1979. Contract EY-76-C-07-1570. 103p. Dep. NTIS, PC E03/MF E03.

The results of three subtasks that complete the assessment of the RELAP4/MOD6 computer code are reported. These subtasks constitute the remainder of a broadly scoped assessment matrix defined and described in detail in a previously published document. The specific subtasks provide comparisons of code calculations with experimental results from core blowdown and critical-flow separate-effects experiments and from an integral systems-effects loss-of-coolant experiment. The basic emphasis of the comparisons is in the presentation of the study results in error form suitable for statistical analysis.

3045 (EGG-SEMI—5025) **Test prediction for Semiscale Mod-3 Test S-SB-2: small break test series.** Murri, B.W.; Snider, D.M.; Dingman, S.E.; Fineman, C.P. (EG and G Idaho, Inc., Idaho Falls (USA)). Sep 1979. Contract EY-76-C-07-1570. 77p. Dep. NTIS, PC A05/MF A01.

This document contains a pretest analysis of the Semiscale Mod-3 system thermal-hydraulic response for the first test in the small break test series (Test S-SB-2). This test series was designed to be compatible with small break loss-of-coolant experiments defined for the Loss-of-Fluid Test (LOFT) Program and computer code calculations performed by the Code Assessment and Applications Program to predict pressurized water reactor (PWR) system behavior during a small break loss-of-coolant accident (LOCA). Results of the Semiscale small break tests will be used to investigate scaling effects pertinent to LOFT and Semiscale and to assess analytical models used in the computer codes. Test S-SB-2 is an integral small break loss-of-coolant test associated with the Semiscale small break test series. The primary objective of Test S-SB-2 is to provide information on the natural circulation phenomena and the potential for core uncovery which may result from the slow depressurization during a small break in the primary cold leg pipe near the vessel for the case where high pressure injection flow is not sufficient to makeup system mass discharged through the break.

3046 (EGG-TFBP—5013) **Loss-of-coolant accident test series TC-1 experiment operating specifications.** Yackle, T.R. (EG and G Idaho, Inc., Idaho Falls (USA)). Sep 1979. Contract EY-76-C-07-1570. 61p. Dep. NTIS, PC A04/MF A01.

The purpose of this document is to specify the experiment operating procedure for the test series TC-1. The effects of externally mounted cladding thermocouples on the fuel rod thermal behavior during LOCA blowdown and reflood cycles will be investigated in the test. Potential thermocouple effects include: (a) delayed DNB, (b) momentary cladding rewets following DNB, (c) premature cladding rewet during a blowdown two-phase slug period, and (d) early cladding rewet during reflood. The two-phase slug period will be controlled by momentarily opening the hot leg valve. The slug will consist of lower plenum liquid that is sent through the flow shrouds and will be designed to quench the fuel rods at a rate that is similar to the slug experienced early in the LOFT L2-2 and L2-3 tests.

3047 (GEFR—00468) **GE-LOA-2 tasks. 1979 annual report, October 1978-June 1979.** (General Electric Co., Sunnyvale, CA (USA). Advanced Reactor Systems Dept.). Jul 1979. Contract EY-76-C-03-0893-007. 130p. AT.

Progress in studies on safe shutdown reliability for large LMFBR type reactors is summarized under the following subtask headings: inherently safe core design, fuel pin accident transients, and fuel pin behavior modeling for TOP conditions.

3048 (HEDL-SA—1731-FP) **Measurement of cladding strain during simulated transient tests.** Duncan, D.R.; Johnson, G.D.; Hunter, C.W.; Hanson, J.E. (Hanford Engineering Development Lab., Richland, WA (USA)). 20 Jul 1979. Contract EY-76-C-14-2170. 13p. (CONF-790816—73). Dep. NTIS, PC A02/MF A01.

From International meeting on fast reactor safety technology; Seattle, WA, USA (19 Aug 1979).

A diametral extensometer was developed and employed during temperature ramp tests with the Fuel Cladding Transient Tester (FCTT). Plastic strain measurements were performed using unirradiated 20% cold-worked AISI 316 stainless steel tubing ramped at 5.6 and 111°C/s with internal pressures from 3.4 to 93.1 MPa. Results demonstrated that plastic deformation can occur at stresses well below the conventional 0.2% yield strength and that most deformation in such tests occurs in the final 50°C before failure. Postirradiation tests were performed on fuel pin cladding irradiated to 5.8 x 10^{22} n/cm (E > 0.1 MeV) with irradiation temperatures to 540°C. The tests showed that, for test pressures of 17.2 MPa or less, the stress-strain behavior was unchanged from unirradiated material behavior although the strains at failure were greatly decreased.

3049 (HEDL-SA—1736-FP) **FFTF containment of hypothetical accidents.** Peak, R.D.; Martin, H.C.; Jensen, R.L.; Stepnewski, D.D.; Hale, J.P. (Hanford Engineering Development Lab., Richland, WA (USA)). Aug 1979. Contract EY-76-C-14-2170. 18p. (CONF-790816—70). Dep. NTIS, PC A02/MF A01.

From International meeting on fast reactor safety technology; Seattle, WA, USA (19 Aug 1979).

The FFTF facility was evaluated for the consequences of an HCDA followed by failure of in-vessel post-accident heat removal, reactor vessel melt-through, and release of core debris and sodium coolant to the reactor cavity. Two cases are presented based on parameters considered to represent upper limits for rates of chemical and thermal attack of the reactor cavity concrete containment structure. The reactor containment building temperature, pressure, and leak rate histories were computed with the CACECO code which provided input into the HAA-3C code for prediction of aerosol behavior, and to the COMRADEX-H code for prediction of radioactivity dispersion. The resultant 30-day doses at the site boundary were judged to be acceptable considering the conservatism in the analysis and the low probability of the event.

3050 (HEDL-SA—1752-FP) **Survival of peripheral pins during a TOP-HCDA.** Yung, S.C.; Wilburn, N.P. (Hanford Engineering Development Lab., Richland, WA (USA)). Jul 1979. Contract EY-76-C-14-2170. 19p. (CONF-790816—65). Dep. NTIS, PC A02/MF A01.

From International meeting on fast reactor safety technology; Seattle, WA, USA (19 Aug 1979).

This study addresses the survival of peripheral pins within an LMFBR subassembly during an unprotected Transient Overpower

(TOP) Hypothetical Core Disruptive Accident (HCDA) by consideration of intrasubassembly incoherencies. A continuous analysis was made vs time from the initiation of the accident up to the point where the power decreases to a quasi-steady state for a Beginning-of-Cycle-4 (BOC-4) core of Fast Test Reactor (FTR), 0.5$/sec ramp case. Blockage was assumed to be formed after fuel pin's failure and effects due to blockages were examined. The study concludes that most peripheral pins within an LMFBR subassembly indeed will survive.

3051 (HEDL-TME—79-2) **Analytical validation of the CACECO containment analysis code.** Peak, R.D. (Hanford Engineering Development Lab., Richland, WA (USA)). Aug 1979. Contract EY-76-C-14-2170. 193p. Dep. NTIS PC E05/MF E05.

The CACECO containment analysis code was developed to predict the thermodynamic responses of LMFBR containment facilities to a variety of accidents. This report covers the verification of the CACECO code by problems that can be solved by hand calculations or by reference to textbook and literature examples. The verification concentrates on the accuracy of the material and energy balances maintained by the code and on the independence of the four cells analyzed by the code so that the user can be assured that the code analyses are numerically correct and independent of the organization of the input data submitted to the code.

3052 (HEDL-TME—79-42) **Uncertainty analysis of consequences calculated by large computer codes.** Nguyen, D.H. (Hanford Engineering Development Lab., Richland, WA (USA)). Sep 1979. Contract EY-76-C-14-2170. 59p. AT.

A methodology has been constructed to assess the uncertainty in an output consequence calculated by a large code, due to the uncertainties in input data. An application was made to the computer code MELT-IIIA to determine the confidence level in predicting the time of initial pin failure during a TOP accident in the FTR.

3053 (IDO—1570-T23) **WRRD monthly report, August 1979.** (EG and G Idaho, Inc., Idaho Falls (USA)). Sep 1979. Contract EY-76-C-07-1570. 166p. Dep. NTIS, PC A08/MF A01.

Overall cost summaries are presented for the Semiscale program; thermal fuels behavior program; 3-D program; code assessment and analysis program; and code assessment and applications program.

3054 (IDO—1570-T24) **WRRD monthly report, September 1979.** (EG and G Idaho, Inc., Idaho Falls (USA)). Oct 1979. Contract EY-76-C-07-1570. 172p. Dep. NTIS, PC A08/MF A01.

Overall cost summaries are presented for the Semiscale program; thermal fuels behavior program; 3-D program; code assessment and analysis program; and code assessment and applications program.

3055 (INKA-Conf—78-049-000, pp vp) **Probabilistic reliability analysis of containments using the example of a PWR reactor.** Kafka, P. (Gesellschaft fuer Reaktorsicherheit m.b.H. (GRS), Koeln (Germany, F.R.)); Schueller, G.I. (Technische Univ. Muenchen (Germany, F.R.)). 1978. (In German).

From GRS experts' talk on nuclear power plant containments; Koeln, F.R. Germany (19 Oct 1978).

The aim of the BMFT supported research project, which is presented here, is to contribute to the development of methods for quantification of risks involved in the design and construction of nuclear power plants. For this purpose a reliability analysis of a large component, i.e. the containment of a power plant was carried out. To accomplish this, detailed information from several fields had to be developed and arranged. The project is mainly concerned with the loading conditions following a LOCA, the material properties of the containment steel, the concrete behavior under impact and finally with the analysis of possible external loading conditions of the containment. The results of these concentrated research efforts were then assembled to a reliability assessment procedure. The method is demonstrated by applying the theoretical findings to the practical problem of analysing the containment of the power plant Biblis-B.

3056 (NUREG—0585) **TMI-2 Lessons Learned Task Force. Final report.** (Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Reactor Regulation). Oct 1979. 47p. NTIS.

In its final report reviewing the Three Mile Island accident, the TMI-2 Lessons Learned Task Force has suggested change in several fundamental aspects of basic safety policy for nuclear power plants. Changes in nuclear power plant design and operations and in the regulatory process are discussed in terms of general goals. The appendix sets forth specific recommendations for reaching these goals.

3057 (NUREG/CR—0468) **Nuclear power plant fire protection: fire barriers (Subsystem Study Task 3).** Minor, E.E.; Berry, D.L. (Sandia Labs., Albuquerque, NM (USA)). Sep 1979. Contract EY-76-C-04-0789. 52p. (SAND—78-1990). Dep. NTIS, PC A04/MF A01.

Standards currently used in the fire protection field are analyzed in relation to their applicability to nuclear power stations and recommendations concerning their improvement are made. Results of mathematical analyses of typical fire barriers are given. Based on the temperature gradient established in the mathematical analyses, a stress analysis of poured concrete walls is described. Recommendations are made for follow-up studies and experiments.

3058 (NUREG/CR—0860) **Summary and bibliography of safety-related events at boiling-water nuclear power plants as reported in 1978.** Scott, R.L.; Gallaher, R.B. (Oak Ridge National Lab., TN (USA)). Sep 1979. Contract W-7405-ENG-26. 28p. (ORNL/NUREG/NSIC—164). Dep. NTIS, PC E02/MF E02.

A bibliography is presented on microfiche that contains 100-word abstracts of reports submitted to the US Nuclear Regulatory Commission concerning operational events that occurred at boiling-water-reactor nuclear power plants in 1978. The 1239 abstracts included in the bibliography describe off-normal incidents, failures, and design or construction deficiencies that were experienced at the facilities. They are arranged alphabetically by reactor name and then chronologically for each reactor. Keyword and permuted-title indexes are provided to facilitate location of the abstracts of interest. Tables that summarize the information contained in the bibliography are also provided. The information in the tables includes a listing of the equipment items involved in the events reported and the associated number of reports for each item. Similar information is given for the various kinds of instrumentation and systems, causes of the failures, deficiencies noted, and the time of occurrence (i.e., during refueling, operation, testing, or construction). Three of the more interesting events that occurred during the year are reviewed in detail.

3059 (NUREG/CR—0871) **Water reactor safety programs sponsored by the Nucelar Regulatory Commission's Division of Reactor Safety Research. Quarterly technical progress report, April-June 1979.** Claflin, D.J.; Wills, E.L. (eds.). (EG and G Idaho, Inc., Idaho Falls (USA)). Jul 1979. Contract EY-76-C-07-1570. 54p. (TREE—1300). Dep. NTIS, PC A04/MF A01.

Water reactor research performed by EG and G Idaho, Inc., during April through June 1979 is reported. Major effort was extended in conducting computer simulations of events that occurred at the Three Mile Island power plant (TMI-2) and in performing tests in the Semiscale facility to support investigation of the TMI-2 transient. The LOFT Experimental Program completed two loss-of-coolant experiments: the second nuclear experiment and a nonnuclear experiment involving a small break caused by opening the pressurizer relief valve were successfully performed. The Thermal Fuels Behavior Program completed testing of LOFT lead rods in the Power Burst Facility. The RELAP5/MOD0 blowdown code was completed and released. The Code Assessment and Applications Program assessed the thermal-hydraulics code RELAP4/MOD6 and the fuel rod analysis code FRAPCON-1. Results are reported of air-water instrumentation tests and flow calibration testing of an instrumented spool piece by the 3-D Experiment Project.

3060 (NUREG/CR—0884) **Updated work plan for the FAST/CRI-III fuel vaporization and transport experiments.** Wright, A.L.; Smith, A.M. (Oak Ridge National Lab., TN (USA)). Oct 1979. Contract W-7405-ENG-26. 39p. (ORNL/NUREG/TM—326). Dep. NTIS, PC A03/MF A01.

This report presents the work plan for the Containment Research Installation-III (CRI-III) tests and the Fuel Aerosol Simulant Tests (FAST) which constitute tasks 4 and 5, respectively, of the Aerosol Release and Transport Program, sponsored by the Division of Advanced Reactor Safety Research of the Nuclear Regulatory Commission. Both tests utilize the capacitor discharge vaporization technique to place uranium dioxide fuel samples into the high energy states that could be produced in Liquid-Metal Fast Breeder Reactor hypothetical core-disruptive accidents. The FAST experiments described will be performed under water and under sodium. These tests will help to develop models to predict fuel aerosol source release in accidents and also to verify models in the SIMMER accident analysis code being developed at Los Alamos Scientific Laboratory. The CRI-III tests will be performed to develop the capability to simultaneously vaporize three fuel samples; in addition, special testing will answer questions related to previous argon energy density tests.

3061 (NUREG/CR—0899) **High-temperature gas-cooled reactor safety studies for the Division of Reactor Safety Research. Quarterly progress report, January 1-March 31, 1979.** Ball, S.J.; Cleveland, J.C.; Conklin, J.C.; Ditto, S.J. (Oak Ridge National Lab., TN (USA)). Oct 1979. W-7405-ENG-26. 42p. (ORNL/NUREG/TM—336). Dep. NTIS, PC, A03/MF A01.

Further development work was done on the ORECA, BLAST, and FLODIS codes. BLAST was adapted to the West German THTR steam generator design. The refurbishing of the FLODIS code was completed, and sample calculations of design-basis depressurization accidents (DBDAs) and loss-of-forced-con-

vection (LOFC) accidents were run to make comparisons with other calculations. Followup investigations were also made of the Fort St. Vrain (FSV) reactor oscillation problems.

3062 (NUREG/CR—0903) **Fuel rod behavior during Test PCM-4.** Johnson, R.L.; Lassahn, P.L.; Martinson, Z.R.; Sparks, D.T.; Schwieder, D.H. (Idaho National Engineering Lab., Idaho Falls (USA)). Aug 1979. Contract EY-76-C-07-1570. 88p. (TREE—1336). Dep. NTIS, PC E03/MF E03.

This report presents and discusses the results from Test PCM-4 of the Power-Cooling-Mismatch Test Series. The test was conducted by EG & G Idaho, Inc., in the Power Burst Facility (PBF) for the US Nuclear Regulatory Commission. The test was performed primarily to obtain fuel rod behavior data under sustained film boiling conditions. Additional information to determine the power level and flow rate required to induce departure from nucleate boiling (DNB), and to characterize propagation and termination of film boiling was obtained. Four individually shrouded, pressurized water reactor (PWR) type fuel rods were subjected to four DNB cycles under PWR environmental conditions in the PBF in-pile test loop. Departure from nucleate boiling was induced by reducing the coolant flow while maintaining linear rod peak power constant at about 68 kW/m. During the fourth cycle, sustained film boiling occurred for over 100 s and cladding temperatures exceeded the zircaloy beta phase transformation temperature (> 1245 K). The fuel rod behavior during film boiling and the fuel rod damage as a result of the high temperature operation are discussed and conclusions are presented. The onset, propagation, and termination of film boiling are also discussed.

3063 (NUREG/CR—0959) **Experiment data report for LOFT nonnuclear small break experiment L3-0.** Prassinos, P.G.; Galusha, B.M.; Jarrell, D.B. (EG and G Idaho, Inc., Idaho Falls (USA)). Aug 1979. Contract EY-76-C-07-1570. 130p. (TREE—1390). Dep. NTIS, PC A07/MF A01.

Experiment L3-0 was the first Small Break Series L3 experiment conducted at the Loss-of-Fluid Test facility. This experiment was performed to obtain data for analytical code assessment and further understand the thermal-hydraulic behavior which occurs during a postulated loss-of-coolant accident in a pressurized water reactor. The specific objectives of Experiment L3-0 were to (a) determine the break flow rate from available pressurizer pressure and level data, (b) provide data to assess the transient pressure, temperature and density for comparison with predictions from computer codes which model small break transients, (c) determine if chugging occurs in the suppression tank during the small break blowdown, and (d) provide operator training in performing small break experiments. Recorded data for Experiment L3-0 are presented.

3064 (NUREG/CR—0993) **Nuclear reactor safety. Quarterly progress report, April 1-June 30, 1979.** Jackson, J.F.; Stevenson, M.G. (comps.). (Los Alamos Scientific Lab., NM (USA)). Aug 1979. Contract W-7405-ENG-36. 188p. (LA—7968-PR). Dep. NTIS, PC A09/MF A01.

Progress in reactor safety research is summarized. LWR studies include TRAC code development for thermal-hydraulic analysis of accidents, containment systems evaluation, and safety experiments. LMFBR studies include SIMMER code development and applications and evaluation of fuel and clad motion diagnostics. HTGR studies cover structural evaluation, phenomena modeling, systems analysis, and accident delineation. GCFR low-power safety experiments are also included.

3065 (NUREG/CR—1025) **Design basis neutronics calculations for NRU-LOCA experiments.** Heaberlin, S.W.; Jenquin, U.P.; McNair, G.W.; Perry, R.T.; Trapp, T.J.; Zimmerman, M.G. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Aug 1979. Contract EY-76-C-06-1830. 135p. (PNL—3113). Dep. NTIS, PC A07/MF A01.

The report describes the neutronics analysis for the LOCA simulation experiments in the NRU reactor. The experimental program will provide greater understanding of nuclear fuel assembly behavior during the heatup, reflood and quench sequence of a hypothetical LOCA. The decay heat and stored heat, which are the energy source in a LOCA will be simulated by fission heat provided by the NRU reactor. The reactor, the test and test operation are described.

3066 (NUREG/CR—1040) **Light-water-reactor safety research program. Quarterly progress report, January-March 1979.** (Argonne National Lab., IL (USA)). Aug 1979. Contract W-31-109-ENG-38. 48p. (ANL—79-43). Dep. NTIS, PC A03/MF A01.

This progress report summarizes the Argonne National Laboratory work performed during January, February, and March 1979 on water-reactor-safety problems. The following research and development areas are covered: (1) Loss-of-coolant Accident Research: Heat Transfer and Fluid Dynamics; (2) Transient Fuel Response and Fission-product Release Program; and (3) Mechanical Properties of Zircaloy Containing Oxygen.

3067 (NUREG/CR—1058) **Impact of SIMMER-II model uncertainties on predicted postdisassembly dynamics.** Bell, C.R.; Burns, R.D. III; Luck, L.B. (Los Alamos Scientific Lab., NM (USA)). Oct 1979. Contract W-7405-ENG-36. 60p. (LA—8053-MS). Dep. NTIS, PC A04/MF A01.

The SIMMER-II calculation of the system kinetic energy developed during a voided core postdisassembly expansion in a hypothetical loss of flow (LOF) accident sequence gives results which are more than an order of magnitude below that for an ideal expansion. This work attempts to determine the extent to which uncertainties in the various phenomenological models in SIMMER-II influence the calculated results. A series of 15 separate SIMMER-II calculations were designed to make this assessment. The system kinetic energies which resulted ranged from 2.5 to 20 MJ compared to 100 MJ for the ideal expansion. It is concluded that experimental research in the area of voided core expansions should entail a balance between two areas. First, experiments should be performed that test the major uncertainties in the sequence of events as outlined in this report. Second, in order to increase confidence in the ability of SIMMER to predict other classes of expansion, testing of isolated phenomenological models should proceed.

3068 (ORNL/CSD—45) **Observations on risk analysis.** Thompson, W.A. Jr. (Oak Ridge National Lab., TN (USA); Oak Ridge Y-12 Plant, TN (USA)). Nov 1979. Contract W-7405-ENG-26. 26p. Dep. NTIS, PC A03/MF A01.

This paper briefly describes WASH 1400 and the Lewis report. It attempts to define basic concepts such as risk and risk analysis, common mode failure, and rare event. Several probabilistic models which go beyond the WASH 1400 methodology are introduced; the common characteristic of these models is that they recognize explicitly that risk analysis is time dependent whereas WASH 1400 takes a per demand failure rate approach which obscures the important fact that accidents are time related. Further, the presentation of a realistic risk analysis should recognize that there are various risks which compete with one another for the lives of the individuals at risk. A way of doing this is suggested.

3069 (ORNL/TM—6947) **ORNL breeder reactor safety: LOA 2, 3, 4, and 5. Quarterly technical progress report, January-March 1979.** Fontana, M.H. (Oak Ridge National Lab., TN (USA)). Sep 1979. Contract W-7405-ENG-26. 146p. AT.

Progress is summarized for the following lines-of-assurance (LOA) tasks: thermal-hydraulic out-of-reactor safety program, analytical models for energetics accommodation, environmental assessment of alternate FBR fuels, model evaluation of breeder reactor radioactivity releases, Nuclear Safety Information Center, breeder reactor reliability data analysis center, and central data base for breeder reactor safety codes.

3070 (RE-A—78-229) **Investigation of the steam void collapse waterhammer initiating mechanism.** Demmie, P.N. (Idaho National Engineering Lab., Idaho Falls (USA)). Feb 1979. Contract EY-76-C-07-1570. 32p. Dep. NTIS, PC A03/MF A01.

A investigation of the steam void collapse waterhammer initiating mechanism was made. The results and conclusions of this investigation are presented and discussed.

3071 (RE-A—78-261(Rev.2)) **Analysis tool for predicting transient hydrodynamics in nuclear piping systems containing swing check valves.** Berry, R.A. (Idaho National Engineering Lab., Idaho Falls (USA)). Sep 1979. Contract EY-76-C-07-1570. 222p. Dep. NTIS, PC A10/MF A01.

An analysis tool is constructed for the purpose of predicting the fluid transient in a piping system as a consequence of (or in site of) a check valve being present in the system. The development of the check valve model along with its implementation into a fluid flow analysis computer program is documented. The analysis tool requirements are outlined and the valve flow and disk dynamics are established. A sample demonstration problem was run using the analysis tool and the results reported. Several supporting documents for the transient fluid flow analysis computer program are also included in the appendices.

3072 (RE-E—79-009) **Analysis tool for predicting the transient hydrodynamics resulting from the rapid filling of voided piping systems.** Williamson, R.L. (EG and G Idaho, Inc., Idaho Falls (USA)). Feb 1979. Contract EY-76-C-07-1570. 180p. Dep. NTIS, PC A09/MF A01.

An analysis tool is constructed for the purpose of predicting the transient hydrodynamics resulting from the rapid filling of voided piping systems. The basic requirements of such an analysis tool are established, and documentation is presented for several fluid transient computer codes which were considered for the tool. The code modifications necessary to meet the analysis tool requirements are described. To test the computational capability of the analysis

tool a verification problem is considered and the results reported. These results serve only to demonstrate the applicability of the analysis tool to this type of problem; the code has not been validated by comparison with experiment. Documentation is provided for a brief sensitivity study involving the sample problem. Additional analysis tool information, as well as detailed sample problem results are included in the form of appendices.

3073 (SAND—79-1733C) **Model and computer code for energy and mass transport in decomposing concrete and related materials.** Knight, R.L.; Beck, J.V. (Sandia Labs., Albuquerque, NM (USA)). 1979. Contract EY-76-C-04-0789. 6p. (CONF-790816—54). Dep. NTIS, PC A02/MF A01.

From International meeting on fast reactor safety technology; Seattle, WA, USA (19 Aug 1979).

In an HCDA, it is postulated that liquid metal coolants and more materials come in contact with the retaining concrete structure. A mathematical model and an associated computer program have been developed to describe the transient heat and mass transfer in the concrete. The program is unique in that it includes: (1) chemical reactions involving free water, chemically bound water and CO_2; (2) an implicit calculational procedure; and (3) change of the porosity as the concrete is decomposed. Predictions of the model are compared with experimental results obtained at Sandia Laboratories and at Hanford Engineering Development Laboratory.

3074 (SAND—79-1963C) **Two-phase jet loads.** Tomasko, D. (Sandia Labs., Albuquerque, NM (USA)). 1979. Contract EY-76-C-04-0789. 26p. (CONF-791118—1). Dep. NTIS, PC A03/MF A01.

From 7. water reactor safety research information meeting; Gaithersburg, MD, USA (5 Nov 1979).

The ultimate objective of the Sandia Labs Program on two-phase jet loads is to develop an approximate engineering model characterizing two-phase jets emanating from circumferential or longitudinal breaks in a typical PWR piping system. Most of the work performed to date has focused on this second task. Three computer codes have been employed to investigate jet load experiments in detail. There are: BEACON/MOD2-INEL; CSQ - Sandia Labs; and TRAC-P1A - LASL.

3075 (SRD-R—159) **Effect of uncertainties in thermophysical properties of UO_2 and sodium on MFCI's.** MacInnes, D.A.; Martin, D.; Vaughan, G.J. (UKAEA Safety and Reliability Directorate, Culcheth). Jul 1979. 13p. Dep. NTIS (US Sales Only), PC A09/MF A01.

Work performed under United States-UKAEA Fast Reactor Exchange Program.

Recent work has led to the values of the physical properties of molten UO_2 and sodium to be questioned. The effect of these uncertainties on MFCI's is investigated - in particular, how the interface temperature/spontaneous nucleation temperature criterion for an interaction to occur and its yield are changed. It is concluded that it is not possible to exclude MFCI's between UO_2 and sodium by this criterion given the present uncertainties.

3076 (UCID—18135-79-1) **US NRC/LLL liaison with the Federal Republic of Germany for the GKSS-PSS steam condensation tests. Progress report No. 1.** McCauley, E.W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 25 Jun 1979. Contract W-7405-ENG-48. 76p. Dep. NTIS, PC A05/MF A01.

This progress report for the USNRC/LLL Liaison program with the Federal Republic of Germany regarding boiling water reactor containment multivent steam condensation tests being conducted by GKSS (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt) address program activity during the period of May-June 1979. During this period the program scope was defined, initial contacts between LLL and GKSS were established, and the first trip by an LLL representative to the GKSS test facility was taken.

3077 (UCRL—15077) **Seismic risk analysis for Battelle Memorial Institute Nuclear Research Facility, West Jefferson, Ohio.** (TERA Corp., Berkeley, CA (USA)). 29 Dec 1978. Contract W-7405-ENG-48. 42p. Dep. NTIS, PC A03/MF A01.

TERA Corporation presents the results of a detailed seismic risk analysis of the Battelle Memorial Institute's Nuclear Research Facility at West Jefferson, Ohio. This report focuses on earthquakes.

3078 (UCRL—81567) **Coupled fluid-structure method for pressure suppression analysis.** McMaster, W.H.; Norris, D.M. Jr.; Goudreau, G.L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1979. Contract W-7405-ENG-48. 10p. (CONF-790802—76). Dep. NTIS, PC A02/MF A01.

From International conference on structural mechanics in reactor technology; Berlin, F.R. Germany (13 Aug 1979).

We have coupled an incompressible Eulerian hydrodynamic algorithm to a Lagrangian finite-element shell algorithm for the analysis of pressure suppression in boiling water reactors. The computer program calculates loads and structural response from air and steam blowdown and the oscillating condensation of steam bubbles in a water pool. The fluid, structure, and coupling algorithms have been verified by the calculation of solved problems from the literature and from air and steam blowdown experiments. The foundation of the program is the semi-implicit, two-dimensional SOLA algorithm. The shell structure algorithm uses conventional thin-shell theory with transverse shear. The finite-element spatial discretization employs piecewise-linear interpolation functions and one-point quadrature applied to conical frustra. We use the Newmark implicit time-integration method implemented as a one-step module. The algorithms are strongly coupled in the iteration loop using the iterated pressure in the fluid to drive the structure. The coupling algorithm requires normal velocity compatibility at the fluid-structure interface and incompressibility of the computational Eulerian zone overlaid by the structure. This is accomplished by iterating on the pressure field which is applied to the structure during each iteration until both conditions are satisfied.

3079 (UCRL—82227) **Operator/instrumentation interactions during the Three Mile Island incident.** Cummings, G.E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Oct 1979. Contract W-7405-ENG-48. 4p. (CONF-791060—1). Dep. NTIS, PC A02/MF A01.

From IEEE symposium on nuclear power systems; San Jose, CA, USA (19 Oct 1979).

A discussion is presented of the operator/instrumentation interactions which had an effect on the course of the incident at the Three Mile Island-2 Nuclear Power Plant. A brief review of the sequence of occurrences at TMI-2 over the first 16 hours of the incident is given with particular emphasis on operator/instrumentation interactions. A breakdown of the six major items that seemed to have contributed to the characteristics of the incident is then given and also an outline of some of the currently proposed operator/instrumentation improvements. The six major items involve water level indication in the reactor, electromatic relief valve operation, auxiliary feed-water flow indication, containment isolation, extended range instrumentation, and computer readout.

3080 (UCRL--83489) **Atmospheric Release Advisory capability (ARAC) response to the Three Mile Island accident.** Dickerson, M.H.; Gudiksen, P.H. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Oct 1979. Contract W-7405-ENG-48. 5p. (CONF-791037—3). Dep. NTIS, PC A02/MF A01.

From IEEE nuclear science symposium; San Francisco, CA, USA (17 Oct 1979).

This paper discusses the three general classes of support provided by the Atmospheric Release Advisory Capability (ARAC) and describes the role played by ARAC in support of DOE during the Three Mile Island accident in March and April of 1979.

3081 (WAPD-TM—1450) **FLASH6 simulation of semiscale blowdown data, NRC Standard Problems 2 and 3: (LWBR Development Program).** Harris, B.D.; Prelewicz, D.A.; Beus, S.G. (Bettis Atomic Power Lab., West Mifflin, PA (USA)). Sep 1979. Contract EY-76-C-11-0014. 70p. Dep. NTIS, PC A04/MF A01.

FLASH6 computer program calculations are compared with experimental data from two simulated loss-of-coolant accident blowdown tests which are designated as numbers 2 and 3 in the Standard problem Series sponsored by the Nuclear Regulatory Commission for reactor safety assessment. Both tests are isothermal blowdowns smulating a double-ended, cold-leg break and were conducted in the electrically-heated, 1-1/2 Loop Semiscale System at Idaho National Engineering Laboratory. The blowdown tests were initiated at nominal conditions of 575°F, 2250 psia and 17.3 lbm/sec loop flow rate.

ENERGY STORAGE

REFER ALSO TO CITATION(S) 2897

3082 (CONF-781231—) **Energy technology.** (Sandia Labs., Livermore, CA (USA)). 1979. Contract EY-76-C-04-0789. 476p. Dep. NTIS, PC A21/MF A01.

From 3. annual thermal energy storage contractor's information exchange meeting; Springfield, VA, USA (5 Dec 1978).

Separate abstracts have been prepared for the individual papers. (TFD)

3083 (DOE/EV—0046(Vol.3), pp 289-312) **Environmental considerations in R and D planning and evaluation of energy storage systems.** Holt, L. (Dept. of Energy, Washington, DC). Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

Consideration of environmental issues as an integral part of planning for technology development is mandated by the National

Environmental Policy Act (NEPA) of 1969. In the Interim Management Directive of January 1978, the Department of Energy (DOE) established policy to identify, characterize, assess and mitigate real and potentially adverse environmental impacts in all DOE programs. In compliance with these regulations, the Division of Energy Storage Systems periodically reviews all energy storage projects to ensure that environmental issues are being appropriately considered. An overview is presented of the planning approach to integrate environmental considerations into the overall energy storage R and D program development, as well as presents methodology to identify and prioritize environmental concerns and potential benefits. Examples of specific energy storage projects are discussed.

MAGNETIC

REFER ALSO TO CITATION(S) 2968

3084 (LA—7885-MS(Vol.2)) **1-GWh diurnal load-leveling superconducting magnetic energy storage system reference design. Appendix A: energy storage coil and superconductor.** Schermer, R.I. (Los Alamos Scientific Lab., NM (USA)). Sep 1979. Contract W-7405-ENG-36. 30p. Dep. NTIS, PC A03/MF A01.

The technical aspects of a 1-GWh Superconducting Magnetic Energy Storage (SMES) coil for use as a diurnal load-leveling device in an electric utility system are presented. The superconductor for the coil is analyzed, and costs for the entire coil are developed.

3085 (LA—7885-MS(Vol.3)) **1-GWh diurnal load-leveling superconducting magnetic energy storage system reference design. Appendix B: cost study, high-purity aluminum production.** Cochran, C.N.; Dawless, R.K.; Whitchurch, J.B. (Aluminum Co. of America, Pittsburgh, PA). Sep 1979. Contract W-7405-ENG-36. 12p. Dep. NTIS, PC A02/MF A01.

Cost information is supplied for aluminum with purities of 200, 2000, and 5000 residual resistivity ratio. Two production situations were used for each purity: (1) 1 x 10^6 kg/yr production rate with a 30-yr sustaining market and (2) 1 x 10^6 kg/yr production rate for 2 yrs only. These productions and purities are of interest for manufacturing devices for Superconducting Magnetic Energy Storage. The cost study results are presented as a range and include (1) the selling price of the aluminum for each case, (2) the cost of facilities including construction, engineering, and related costs, (3) the cost of money and depreciation (interest/amortization), and (4) the energy costs - the total of power and fuel. The range is affected by possible production variations and other uncertainties. Information is also given on plant location options and the preferred feed to the purification facility (with ore source effects).

3086 (LA—7885-MS(Vol.5)) **1-GWh diurnal load-leveling superconducting magnetic energy storage system reference design. Appendix D: superconductive magnetic energy storage cavern construction methods and costs.** (Fenix and Scisson, Inc., Tulsa, OK (USA)). Sep 1979. Contract W-7405-ENG-36. 16p. Dep. NTIS, PC A02/MF A01.

The excavation and preparation of an underground cavern to contain a 1-GWh diurnal load-leveling Superconducting Magnetic Energy Storage (SMES) unit is examined. The cavern's principal function is to provide a rock structure for supporting the magnetic forces from the charged storage coil. Certain economic considerations indicate the refrigerator cold box for the helium system should also be underground. The study includes such a provision and considers, among other things, rock bolting, water seepage, concrete lining of the walls, steel bearing pads, a system to prevent freezing of the walls, a mining schedule, and costs.

3087 (LA—7885-MS(Vol.6)) **1-GWh diurnal load-leveling superconducting magnetic energy storage system reference design. Appendix C: dewar and structural support.** Bennett, J.G.; Ju, F.D. (Los Alamos Scientific Lab., NM (USA)). Sep 1979. Contract W-7405-ENG-36. 56p. Dep. NTIS, PC A04/MF A01.

The mechanical aspects of the dewar to contain a 1-GWh superconducting coil in a 1.8 K helium bath and the means for supporting the coil and dewar against the rock of an underground excavation created for just that purpose are presented.

3088 (LA—7885-MS(Vol.8)) **1-GWh diurnal load-leveling Superconducting Magnetic Energy Storage System reference design. Appendix G. Design study. Thyristor converter stations for use with superconducting magnetic energy storage systems.** Lindh, C.B.; Pohl, R.V.; Trojan, H.T. (Los Alamos Scientific Lab., NM (USA)). Sep 1979. Contract W-7405-ENG-36. 26p. Dep. NTIS, PC A03/MF A01.

The cost for the power conversion equipment for four different SMES systems were developed. These were 1- and 5-GWh units for 4- and 8-h charge periods. Only constant power operation of the converter was considered with 10% of the maximum energy remaining in the magnet at the end of the discharge cycle. The cost increases almost linearly with the maximum coil current between 30 kA and 150 kA, and the cost for a 4-h charge system is about 20% lower than for an 8-h charge system. The converter terminal cost is estimated to be $40/kW of installed power for a 1-GWh 4-h charge system at 30 kA maximum current and $60/kW of installed power for a 5-GWh 4-h charge system at 50 kA maximum current.

COMPRESSED GAS

REFER ALSO TO CITATION(S) 3116

3089 (DOE/EV—0046(Vol.3), pp 313-326) **Compressed air energy storage (CAES) environmental control concerns.** Beck, C.A.; Craig, R.A.; Stottlemyre, J.A.; Loscutoff, W.V. (Battelle Pacific Northwest Labs., Richland, WA). Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

The technologies of compressed air energy storage and some of the environmental concerns associated with siting, construction, operation and decommissioning of such a system are described. Also described is an ongoing research program, the goal of which is to evaluate methods to control the effects of these environmental factors.

FLYWHEELS

REFER ALSO TO CITATION(S) 2756, 3396

THERMAL

REFER ALSO TO CITATION(S) 2885, 2886, 2887, 2888, 2889, 2890, 2891, 2892

3090 (CONF-781231—, pp 2-10) **Low-temperature thermal energy storage: program overview.** Eissenberg, D.M. 1979.

From 3. annual thermal energy storage contractor's information exchange meeting; Springfield, VA, USA (5 Dec 1978).

The Low-Temperature Thermal Energy Storage Program is a research and development program managed for DOE/STOR by the Oak Ridge National Laboratory. The objectives of the LTTES Program are to carry out research and development on new technologies for storing thermal energy as low-temperature sensible and latent heat, and to develop, test, and demonstrate cost-effective systems for collecting, storing, and discharging thermal energy which will have significant national impact on energy conservation in the near- and mid-term. The program objectives and scope are defined and the long-range implementation plan for achieving program goals are described.

3091 (CONF-781231—, pp 11-19) **Experimental study of the storage of thermal energy in confined aquifers.** Molz, F.J.; Parr, A.D. (Auburn Univ., AL). 1979.

From 3. annual thermal energy storage contractor's information exchange meeting; Springfield, VA, USA (5 Dec 1978).

The project objectives are: (1) to inject heated water into a confined aquifer, store it for a period of time, and pump it out; (2) to record water temperatures and hydraulic heads during the injection-storage-recovery cycle; and (3) to determine to the extent possible the feasibility of storing thermal energy in confined aquifers. The first of two 6-month injection-storage-recovery cycles has been completed. Relevant data have been collected and are being analyzed. During the injection period a clogging problem occurred. This problem did not, however, prevent attainment of the research objectives. Presently the injection phase of the second injection-storage-recovery cycle has been completed. During this injection the clogging problem was significantly reduced.

3092 (CONF-781231—, pp 21-23) **Storage of cold water in groundwater aquifers for cooling purposes - Phase II.** Reddell, D.L.; Davison, R.R. (Texas A and M Research Foundation, College Station). 1979.

From 3. annual thermal energy storage contractor's information exchange meeting; Springfield, VA, USA (5 Dec 1978).

The project objective is to design, develop, and demonstrate a working prototype system in which water is pumped from an aquifer at 70°F in the winter time, chilled to a temperature of less than 50°F, injected into a groundwater aquifer, stored for a period of several months, pumped back to the surface in the summer time, and used to air condition buildings. The project is divided into two phases as follows: Phase I consisted of construction of the facilities for the study. A pumping well and injection well were drilled and equipped. A cooling pond for chilling the water was constructed.

Pipelines were installed to connect the wells and cooling pond. Observation wells were drilled to observe water pressure and temperatures at various distances from the wells. Phase II was initiated in October 1978 and consists of operating the project. As of December 1, 1978, two million gallons of water had been injected. This water is being pumped back out at the present time to test all instrumentation. We will begin injecting cold water shortly and continue until the end of March. From June through August the cold water will be recovered, and then the cycle repeated during 1979-80 and 1980-81.

3093 (CONF-781231—, pp 25-34) **JFK Airport Aquifer Storage Project: Test Well Drilling Program.** Singer, M.E. (New York State Energy Research and Development Authority, Albany). 1979.

From 3. annual thermal energy storage contractor's information exchange meeting; Springfield, VA, USA (5 Dec 1978).

The project goal is to determine the thicknesses, lateral extent, depths, and stratigraphy of the aquifers underlying the JFK Airport, Long Island, New York. This project was initiated as a result of a proposal and preliminary study by Desert Reclamation Industries of the feasibility of storing cold water in aquifers under the airport for seasonal use in the chilled-water air-conditioning system in the airline terminal buildings. The borehole drilling project is completed. The Jameco-Magothy aquifer ranges in thickness from 87 to 177 ft under the JFK airport. The aquifer is overlain by the Gardiners' Clay and underlain by the Magothy Clay Unit, both of which act as impermeable seals for the aquifer. Initial tests on samples of the Gardiners' Clay indicate that subsidence and upheaval due to removal and storage of water in the aquifer will not be a problem at the airport.

3094 (CONF-781231—, pp 35-43) **Evaluation of thermal energy storage for the proposed Twin Cities District Heating System.** Meyer, C.F. (General Electric Co., Santa Barbara, CA). 1979.

From 3. annual thermal energy storage contractor's information exchange meeting; Springfield, VA, USA (5 Dec 1978).

The project objective is to evaluate the technical and economic feasibility of incorporating thermal energy storage components (primarily based on the annual cycle) into the proposed Twin Cities District Heating Project. The principal effort to date has been gathering information from a number of studies which have been or are still being conducted on various aspects of a proposed cogeneration/district heating project for Minneapolis-St. Paul. The study of principal interest, whose results have not yet been completely reported, is being conducted by the Swedish firm Studsvik Energiteknik AB (formerly AB Atomenergi). They have developed a DH system configuration which includes production of hot water by power plants and peaking boilers; transmission pipeline networks; and distribution systems for the urban and residential areas of the Twin Cities. Studsvik will be a major subcontractor to TEMPO on this TES study.

3095 (CONF-781231—, pp 45-50) **Daily/short term storage program: overview.** Kedl, R.J. (Oak Ridge National Lab., TN). 1979.

From 3. annual thermal energy storage contractor's information exchange meeting; Springfield, VA, USA (5 Dec 1978).

Development of short-term thermal energy storage systems has been a major thrust of the LTTES Program since its inception. A wide variety of concepts are, and have been, under development. They are directed toward the storage of solar energy (active and passive) and off-peak electricity, and involve the storage of either heat or cool. Although these efforts are principally thrusted toward building heating and cooling, they could also find application in the industrial and agricultural sectors. The emphasis has been on the use of phase-change materials (PCM's) as the storage media, although some efforts involving sensible heat storage have been supported. In addition, generic efforts in support of concept development are underway.

3096 (CONF-781231—, pp 55-64) **Life and stability testing of packaged low-cost energy storage materials.** Frysinger, G.R. (Univ. of Delaware, Newark). 1979.

From 3. annual thermal energy storage contractor's information exchange meeting; Springfield, VA, USA (5 Dec 1978).

The package integrity of the CHUB packaged materials will be tested to experimentally verify the ability of the package to retain the moisture within the salt mixture. The life and stability of the packaged material will be verified by thermal cycle and performance measurement. CHUB packages are prepared by Du Pont for mechanical and temperature stability tests. Immediate goal is a qualified CHUB for performance life testing.

3097 (CONF-781231—, pp 65-71) **Experimental investigations of thermal flow in freezing and melting systems.** Deal, R.M. (Oak Ridge National Lab., TN). 1979.

From 3. annual thermal energy storage contractor's information exchange meeting; Springfield, VA, USA (5 Dec 1978).

The project objectives are: (1) assessment of a computer model for thermal energy storage for phase change materials (PCM); (2) collection of fundamental data on heat transfer in freezing and freezing processes in a variety of materials; and (3) provide a facility for the testing of proposed PCM materials. A facility is operating with temperature control for each of two thermal reservoirs and recording of temperatures on a millivolt recorder. The use of a laser as a probe to measure gradients in the liquid phase has been tested and shows promise. An LSI-11 computer system to take data and analyze it and to control the experiment is now being tested.

3098 (CONF-781231—, pp 73-86) **ANL storage assessment and field test program.** Asbury, J.G. (Argonne National Lab., IL). 1979.

From 3. annual thermal energy storage contractor's information exchange meeting; Springfield, VA, USA (5 Dec 1978).

The objectives of the assessment program are to analyze storage technologies that interface with electric supply systems to: (i) determine their cost-effectiveness, (ii) specify commercialization strategies, and (iii) define R and D needs and opportunities. The objectives of the field test program are to evaluate the performance of near-commercial and advanced customer thermal storage technologies under U.S. operating conditions. Customer acceptance, load-leveling benefits, and development needs will be determined. Comprehensive assessments of storage resistance heating, storage air conditioning, storage heat pump, solar/storage/resistance, and solar/storage/heat pump technologies have been performed. Alternative strategies for commercializing customer storage have been analyzed and reported. Work is underway on comparisions of after-the-meter storage technologies and before-the-meter technologies (pumped hydro, compressed air, thermal electric batteries). Solar storage concepts, including seasonal and stratified thermal storage have been analyzed. A general theory to specify and analyze the role of storage in solar-thermal applications is being developed. Electric storage heating systems are being installed in residences in Maine and Vermont. Roughly 20 sample and 20 control residences will have been equipped in each state before the end of the 1978-79 heating season. Data will be collected and preliminary benefit-cost analysis performed during FY 80. A thermal storage test facility will be established at Purdue University during FY 80.

3099 (CONF-781231—, pp 87-95) **Applications of thermal energy storage to waste heat recovery in the food processing industry.** Lundberg, W.L. (Westinghouse Electric Corp., Pittsburgh, PA). 1979.

From 3. annual thermal energy storage contractor's information exchange meeting; Springfield, VA, USA (5 Dec 1978).

The project objectives were to assess the potential for waste heat recovery in the food industry and to evaluate prospective waste heat recovery systems employing thermal energy storage. The project tasks were: (1) waste heat availability and applications survey: (2) waste heat recovery system design; (3) assessment of potential fuel and energy savings in the food industry; and (4) commercialization plan development. The project has been completed and the development of demonstration plans is proceeding.

3100 (CONF-781231—, pp 97-104) **Application of thermal energy storage to process heat and waste heat recovery in the aluminum industry.** Katter, L.B.; Hoskins, R.L. (Rocket Research Co., Redmond, WA). 1979.

From 3. annual thermal energy storage contractor's information exchange meeting; Springfield, VA, USA (5 Dec 1978).

The objectives of the project are to identify application of low-temperature energy storage techniques in the primary aluminum smelting industry which provide significant energy conservation at competitive economics, and quantify the projected national savings from these applications. Aluminum smelting plants reject very large quantitites of waste heat ranging from 250°F to 400°F. During the initial phase of this study, a system has been identified that can utilize this waste heat for comfort heating and hot water in nearby communities. Energy is stored as hot water in steel tanks or aquifers. Analytical trade-off studies conducted for a site specific system (Intalco Aluminum Company and Bellingham, Washington) indicate that a single aluminum plant can provide heat for 12,000 equivalent residences and costs less than existing conventional fuels. A follow-on program is being negotiated to conduct detailed analytical, economic, and implementation studies for Bellingham, Washington.

3101 (CONF-781231—, pp 105-113) **Low temperature thermal storage in aquifers: environmental assessment.** Triegel, E.K. (Oak Ridge National Lab., TN). 1979.

From 3. annual thermal energy storage contractor's information exchange meeting; Springfield, VA, USA (5 Dec 1978).

The objective of the project is to determine the environmental research and documentation needs of the thermal storage in aquifers project, including preparation of the necessary programmatic environmental impact document. The goals of this environmental evaluation are to: (1) determine the scope of the individual projects involved; (2) identify the hydrologic, ecological, aesthetic, societal, economic, and health and safety issues to be addressed and the research needs of those issues; (3) identify the documents required by the NEPA process; (4) identify actions to reduce or mitigate envi-

ronmental impacts; and (5) promote adequate discussion and interchange of environmental information among industry, government, and public groups. Current projects funded by DOE and European programs have been reviewed with respect to their possible environmental impacts; Concerns which may require additional characterization or research have been identified; A document describing the environmental requirements of the project has been prepared; Expected results in FY 1979 will be the preparation of the necessary programmatic environmental impact document.

3102 (CONF-781231—, pp 115-128) **Macro-encapsulation of heat storage phase-change materials.** Lane, G.A. (Dow Chemical Co., Midland, MI). 1979.

From 3. annual thermal energy storage contractor's information exchange meeting; Springfield, VA, USA (5 Dec 1978).

The objectives of the program are: (1) to assess the technical and economic feasibility of encapsulated phase change materials (PCM's) for storing heat in residential solar energy systems; and (2) to develop and evaluate such encapsulated phase change materials. Tasks included: (1) materials selection, including a limited literature search, selection of candidate phase change materials, and selection and characterization of encapsulating materials; (2) procurement of phase-change and encapsulating materials, encapsulation studies, and testing of the encapsulated materials; and (3) preliminary design and economic evaluation of a residence-sized heat storage sub-system. All tasks have been completed.

3103 (CONF-781231—, pp 129-131) **Application of low-temperature thermal energy storage in the TVA region.** Manaker, A.M. (Tennessee Valley Authority, Chattanooga, TN). 1979.

From 3. annual thermal energy storage contractor's information exchange meeting; Springfield, VA, USA (5 Dec 1978).

The objectives of the study include: (1) the identification of potential sources and users of low-temperature thermal energy, such as institutional heating and cooling and industrial processes, in addition to TVA facilities; and (2) the identification of appropriate aquifer sites for storage. Particular emphasis will be given to defining the criteria for storage in aquifers. The project has not yet started. When the project is started, the following five tasks will be performed: (1) survey the TVA region for thermal energy producers; (2) development of criteria for storing thermal energy in aquifers; (3) survey the TVA region for aquifer storage system sites; (4) survey potential thermal energy users in the TVA region; and (5) assess the opportunities for thermal energy storage systems in the TVA region.

3104 (CONF-781231—, pp 143-144) **Low-temperature thermal energy storage (LTTES) program: ORNL, Bellingham subsurface heat storage.** Cline, D.R. (Geological Survey, Tacoma, WA). 1979.

From 3. annual thermal energy storage contractor's information exchange meeting; Springfield, VA, USA (5 Dec 1978).

The objective is to investigate the geology and hydrology of the Bellingham area to determine the occurrence, yield, and water-quality of any deep, undeveloped, confined aquifers that may be used for storing and withdrawing waste heat from aluminum processing. The project has four phases: (1) examine pertinent geological and hydrological data existing in USGS and state agency files; (2) review the sites and performance criteria specifications for test-drilling and data-collection programs of project consultants; (3) collect geologic, hydrologic, and water-quality data on any existing permanent wells and during test drilling, and perform tests on any major aquifers encountered; and (4) write a report describing the geology and hydrology of the area. Some of the existing data have been assembled and examined.

3105 (CONF-781231—, pp 145-147) **Mathematical modeling of moving boundary problems.** Solomon, A. (Oak Ridge National Lab., TN). 1979.

From 3. annual thermal energy storage contractor's information exchange meeting; Springfield, VA, USA (5 Dec 1978).

The objectives of the project are: (1) the further development of a computer model of the moving boundary phase change process in the context of a latent heat TES mechanism; and (2) the derivation and analysis of analytical tools for validating the computer model, and in support of other aspects of the TES program. The project is divided into two phases: (1) determine those aspects of the computer program and of the analytical support work that must be done in support of the program; (2) validate the program by a combination of analytical tools and experimental comparisons. The computer program has been used and compared with a variety of known analytical solutions and approximations and has been found to be valid for all of the cases tested. Comparisons with experimental results and calibration of the program are now being carried out in cooperation with the parallel work of R. Deal. Analytical approximation methods are continuing to be developed for a variety of problems of relevance to the TES program.

3106 (CONF-781231—, pp 149-154) **Development of intermediate temperature thermal energy storage systems.** Moszynski, J.R. (Univ., Delaware, Newark). 1979.

From 3. annual thermal energy storage contractor's information exchange meeting; Springfield, VA, USA (5 Dec 1978).

The objectives of the project are: (1) identify suitable materials for thermal storage in the temperature range, 100 to 300°C; (2) compile pertinent thermophysical data, as far as possible from existing literature; (3) determine missing data as required; (4) build and test a scale model of a storage system using a selected material. Preliminary cost and safety criteria have been formulated. Test cells for thermal cycling, calorimetric measurements and measurements of thermal diffusivity have been designed and built. Scrutiny of materials exhibiting a phase transition in the temperature range of interest has been completed. Through preliminary testing or calculations, energy storage in salt hydrates and in liquid-vapor transitions has been eliminated from consideration for the range of interest. The choice has been narrowed down to four candidate materials which are being submitted for final approval to DOE. These materials are: $NaAlCl_4$, $ZnCl_2$, a eutectic mixture of $FeCl_3$ and $NaCl$ and a eutectic mixture of $NaOH$ and Na_2CO_3. In-depth characterization studies of approved materials will proceed during the remainder of the first year of the contract.

3107 (CONF-781231—, pp 155-164) **Studies of a salt hydrate heat storage system.** Hallett, J. (Univ. of Nevada System, Reno,). 1979.

From 3. annual thermal energy storage contractor's information exchange meeting; Springfield, VA, USA (5 Dec 1978).

The objective of the project is to investigate salt hydrate storage systems from the viewpoint of attaining optimum power characteristics during crystallization and meltdown. Crystallization of a one- and two-component system for thermal storage by fusion heat of salt hydrates has been investigated for sodium sulfate ($10H_2O$), sodium thiosulfate ($5H_2O$) and sodium acetate ($3H_2O$). A continuous input of small crystals which grew and sedimented from the solution aimed to keep heat transfer surfaces crystal free. The two component system utilized kerosene as the heat transfer fluid, which was circulated at 5 mm drops rising by buoyancy through the salt solution. Both of these systems resulted, under appropriate operating conditions, in the formation of secondary crystals to replace those which grew and sedimented. The one component system proved unreliable as occasional nucleation lead to significant crystals growing on the heat transfer surfaces during cooling. The two component system functioned when crystal concentration was sufficiently low (1 cm^{-3}) to permit growth of crystals of size large enough for sedimentation; otherwise crystals remained in suspension throughout the cycle. The operating characteristics and thermal efficiency of these systems were investigated for a laboratory and a pilot unit. From a study of the pilot system using sodium acetate, optimum operating conditions for near constant power output were delineated. Detailed studies were made of solution nucleation, secondary crystal production, linear crystal growth velocity and habit. Physical properties of the solutions were measured for both supersaturated and undersaturated solutions. These included viscosity, refractive index, and density.

3108 (CONF-781231—, pp 166-171) **High efficiency thermal energy storage system for utility applications.** Vrable, D.L.; Quade, R.N. (General Atomic Co., San Diego, CA). 1979.

From 3. annual thermal energy storage contractor's information exchange meeting; Springfield, VA, USA (5 Dec 1978).

A concept of coupling a high efficiency base loaded coal or nuclear power plant with a thermal energy storage scheme for efficient and low-cost intermediate and peaking power is presented. A portion of the power plant's thermal output is used directly to generate superheated steam for continuous operation of a conventional turbine-generator to product base-load power. The remaining thermal output is used on a continuous basis to heat a conventional heat transfer salt (such as the eutectic composition of KNO_3/$NaNO_3$/$NaNO_2$), which is stored in a high-temperature reservoir [538°C (1000°F)]. During peak demand periods, the salt is circulated from the high-temperature reservoir to a low-temperature reservoir through steam generators in order to provide peaking power from a conventional steam cycle plant. The period of operation can vary, but may typically be the equivalent of about 4 to 8 full-power hours each day. The system can be tailored to meet the utilities' load demand by varying the base-load level and the period of operation of the peak-load system.

3109 (CONF-781231—, pp 173-179) **High temperature thermal energy storage project overview.** Masica, W.J. 1979.

From 3. annual thermal energy storage contractor's information exchange meeting; Springfield, VA, USA (5 Dec 1978).

The general objective of the High Temperature Thermal Energy Storage Project is to develop the technology for cost and performance effective thermal energy storage systems for end-use application sectors. The technologies include all sensible and latent heat storage for temperatures above approximately 250°C. Technologies for selected applications will be developed to the point of acceptance by the private sector or for systems integration and field testing by a DOE end-use Division. The Project's activities are

accomplished principally through contracts within the private sector to provide early and effective transfer of technology. Government funds in support of the Project are provided entirely by DOE. Activities are coordinated with complementary projects and tasks being pursued by DOE end-use Divisions and national laboratories, the Solar Energy Research Institute (SERI), the Electric Power Research Institute (EPRI), the Tennessee Valley Authority (TVA), and the Naval Research Laboratory (NRL).

3110 (CONF-781231—, pp 181-190) **Conceptual design of Thermal Energy Storage (TES) Systems for near-term electric utility applications.** Hall, E.W. (General Electric Co., Schenectady, NY). 1979.

From 3. annual thermal energy storage contractor's information exchange meeting; Springfield, VA, USA (5 Dec 1978).

The project objective is to examine the field of proposed concepts for thermal energy storage (TES) systems and select, conceptually design, and analyze the most promising for near term electric utility applications. The technical effort is divided into four tasks: Task I - System Selection; Task II - Conceptual System Designs; Task III - Benefit Analysis; and Task IV - Development and Field Test Program Recommendations. Tasks I and II have been completed and Task III is nearing completion. In Task I over forty TES concepts gleaned from the literature and personal MW(e) contacts were examined for possible application on two reference plants, an 800 MW(e) high-sulfur coal plant, and an 1140 MW(e) light water nuclear plant. A preliminary screening on near term availability and applicability reduced the set to twelve selections, some of which combined the elements of several concepts. Of the twelve, four options were selected and further analyses were made to improve the performance. Conceptual designs of the four options have been completed with heat and mass balances and plant layouts. Analyses have been made of the benefits to utilities, including the cost of electricity, and recommendations will be made for further developments and tests.

3111 (CONF-781231—, pp 197-205) **Active heat exchanger system development for Latent Heat Thermal Energy Storage System.** LeFrois, R.T. (Honeywell, Inc., Minneapolis, MN). 1979.

From 3. annual thermal energy storage contractor's information exchange meeting; Springfield, VA, USA (5 Dec 1978).

The objective is to develop an active heat exchanger system, utilizing a phase change thermal storage medium, where operating characteristics are compatible with a 250° to 350°C steam power cycle. This project is divided into five tasks: (I) sodium nitrate was selected for the medium and two heat exchanger concepts, i.e., a modified shell and tube and a direct contract reflux boiler were recommended and approved; (II) the TES Modules have been designed to test the critical elements of the heat exchanger; (III) detailed designs are complete and bids are in process for the construction of the heat exchangers; (IV) the test phase will commence early in 1979; and (V) the draft version of topical report was delivered and reviewed; and the final version is in process.

3112 (CONF-781231—, pp 207-215) **Active heat exchanger system development for latent heat thermal energy storage system.** Haslett, R.; Alario, J.; Yenetchi, G. (Grumman Aerospace Corp., Bethpage, NY). 1979.

From 3. annual thermal energy storage contractor's information exchange meeting; Springfield, VA, USA (5 Dec 1978).

The objective is to design, build, and test two active heat exchanger concepts which are best suited for latent heat thermal energy storage systems for the utility industry. The project is comprised of five tasks: (1) select suitable TES media and make one primary recommendation (identify candidate HX concepts, evaluate their performance and recommend two for lab testing); (2) prepare detailed designs and test plans for two HX concepts; (3) fabricate the test hardware and perform laboratory tests; (4) analyze the test data and make recommendations for implementation; and (5) issue scheduled monthly reports, a topical and a final report. The primary TES media has been selected (chloride salt eutectic, mp = 725°F). Heat exchanger design concepts have been identified and evaluated; three are candidates for detailed design but two will be selected pending results of element adhesion tests. Element adhesion test apparatus is being assembled and tests will begin soon. The liquid metal carrier direct contact HX concept is entering detailed design.

3113 (CONF-781231—, pp 227-233) **Mathematical modeling of thermal energy storage in aquifers.** Tsang, C.F. (Lawrence Berkeley Lab., CA). 1979.

From 3. annual thermal energy storage contractor's information exchange meeting; Springfield, VA, USA (5 Dec 1978).

The objectives are to use numerical models and other methods to: (1) study and understand the hydrodynamic and thermal behavior of an aquifer under a variety of possible situations when used for hot or chilled water storage; (2) estimate the efficiency of storage and retrieval; and (3) model field experiments. A numerical model has been developed to examine a variety of situations associated with thermal energy storage. The following cases have been studied: (1) annual cycle - seasonal storage; (2) semi-annual cycle; (3) a well partially penetrating the aquifer; (4) storage of water of different temperatures; (5) the effect of a clay lens in the aquifer; (6) inhomogeneity of the aquifer; (7) chilled water storage; (8) a two-well system; (9) the possibility of consolidation or uplift; and (10) natural regional flow.

3114 (CONF-781231—, pp 235-241) **Energy storage-boiler tank.** Chubb, T.A.; Nemecek, J.J. (Naval Research Lab., Washington, DC). 1979.

From 3. annual thermal energy storage contractor's information exchange meeting; Springfield, VA, USA (5 Dec 1978).

The project's goal is to develop a heat-of-fusion energy storage-boiler tank. Laboratory studies with 55 lb of salt are largely complete. Energy input step was verified with 12°C between temperature of liquid heat transfer fluid and 385°C melting point of salt (storage temperature). The salt eutectic ($MgCl_2$, NaCl, KCl) was found compatible with mild steel container material. M-terphenyl was found suitable as the heat transfer fluid for the proof of concept demonstration. A life test of 18 melt-freeze cycles was completed. Site plans for 2 MWh storage facility are now complete. Bid package was prepared and construction proposals have been received. Plans for the 2 MWh storage tank are well-advanced. Prototype salt cans have been received. Salt specifications have been defined. Heat transfer fluid (3500 lb) is on-hand.

3115 (CONF-781231—, pp 244-263) **Thermal energy storage for road vehicle propulsion systems.** Farahat, M.M. (Argonne National Lab., IL). 1979.

From 3. annual thermal energy storage contractor's information exchange meeting; Springfield, VA, USA (5 Dec 1978).

The project's goal is to develop a thermal storage system for application with a heat engine (e.g., Stirling, Rankine or Brayton cycle) to provide propulsion for highway vehicles. The project is divided into four phases as follows: (1) System Studies: to assess technical and economic feasibility and produce conceptual designs. This phase has been completed by awarding two 9-month contracts to Sigma Research, Inc. and Thermo Electron Corporation. Final reports will be submitted by the end of 1978. (2) Concept Development: to fabricate and test first generation thermal energy storage components. 18 months. (3) Technology Validation: to refine first generation component designs to establish the proof-of-concept. 18 months. (4) Demonstration: to package and integrate the TES Subsystem with a suitable heat engine and installed in a compact urban vehicle chassis for test on a dynamometer and for road testing.

3116 (CONF-781231—, pp 265) **Research studies for adiabatic compressed air storage.** Hamilton, N.I. (Massachusetts Inst. of Tech., Lexington). 1979.

From 3. annual thermal energy storage contractor's information exchange meeting; Springfield, VA, USA (5 Dec 1978).

The objective is to investigate the applicability of compressed air energy storage in combination with thermal energy storage for use in electric utility power generation. The combination of solar thermal and off-peak energy shall be used in determining cost and performance models. Particular attention will be focused on the cost and performance of the packed beds for thermal storage. The scope of work consists of three tasks: (I) application of CAES to solar power; (II) preliminary design study of adiabatic CAES; and (III) thermal storage in packed beds. The technical effort has been completed with the following major conclusions: (1) CAES for storage of solar thermal electric power is not practical beacause the combined capital cost is too high and the multiple conversions decrease efficiency; (2) CAES compares favorably to pumpd hydro for conventional utility storage; (3) use of available reservoirs can considerably reduce cost, time, and risk; and (4) thermal storage for adiabatic CAES is technically feasible and economically attractive (low incremental cost 1-7 to 4-6 mills/kwh).

3117 (CONF-781231—, pp 273-283) **Molten salt thermal energy storage systems.** Claar, T.D.; Marianowski, L.G. (Inst. of Gas Technology, Chicago, IL). 1979.

From 3. annual thermal energy storage contractor's information exchange meeting; Springfield, VA, USA (5 Dec 1978).

The project's goals are: (1) define high-temperature TES concepts for water-Rankine electric generating plants and advanced solar-thermal power applications; (2) study cyclic and endurance behavior of candidate salts, primarily carbonates, in lab and engineering scale modules; and (3) investigate means of improving TES heat exchange performance. Definition of a TES/water-Rankine auxiliary peaking generation system has been completed. An 8 kWh TES unit containing $LiKCO_3$ has undergone 129 cycles over temperature range 505 50°C (5650 h) with very stable thermal performance. Design, fabrication, and assembly of three lab-scale TES test stations are completed. Testing of candidate salt over 1000 to 1600°F (538 to 871°C) temperature range is in progress. Tests of porous aluminum heat conduction enhancement material for steam-superheating applications are nearing completion.

3118 (CONF-781231—, pp 285-294) **Heat storage in alloy transformations.** Birchenall, C.E. (Univ. of Delaware, Newark). 1979.

From 3. annual thermal energy storage contractor's information exchange meeting; Springfield, VA, USA (5 Dec 1978).

The project's goals are (1) determine the density with which energy can be stored in solid-liquid phase changes in relatively inexpensive alloys, especially in eutectic transformations; (2) measure the heat capacities and coefficients of thermal expansion near the transformation temperature and the volume change during transformation; and (3) find materials that can contain the best storage systems for long operating periods. Several binary and ternary alloys of the less expensive elements with known eutectic transformations have been shown to have heats of transformation large enough to approach or exceed the best of those previously reported for other materials near their transformation temperatures. Calorimetric measurements continue on known eutectics and congruently-melting intermediate phases. Previously unknown eutectics that may have large heats of transformation are being sought. One new ternary eutectic has been identified. A new method for determining volume change during solid to liquid transformation has been instrumented and tested. The precision and limitations of the method have been explored using pure aluminum. Eutectic transformations in the Al-Cu and Al-Si systems have been measured successfully. Metallic container materials are being studied for chemical compatibility with the best eutectic alloys as alternatives to graphite or ceramics.

3119 (CONF-781231—, pp 295-303) **Heat transfer in thermal energy storage systems based on phase change.** Shamsundar, N. (Univ. of Houston, TX). 1979.

From 3. annual thermal energy storage contractor's information exchange meeting; Springfield, VA, USA (5 Dec 1978).

The project's goals are to develop design methods, design graphs and obtain thermal performance data on latent heat storage devices. The project is divided into five phases: (1) obtain design data for shell and tube heat exchangers; (2) develop simplified design formulae; (3) compare predicted thermal performance with experimental data; (4) develop methods for treating time-dependent loads; and (5) study new prediction models. The status on each phase is as follows: (1) complete data obtained; (2) formulae developed for several cases; (3) experimental data scanty - experiments being conducted; (4) successful method developed; and (5) model to account for liquid superheat developed and verified.

3120 (CONF-781231—, pp 305) **Combined thermal storage and transport for utility applications.** Hausz, W. (General Electric Co., Santa Barbara, CA). 1979.

From 3. annual thermal energy storage contractor's information exchange meeting; Springfield, VA, USA (5 Dec 1978).

The project parallels a study of thermal energy storage for utility applications supported both by DOE/NASA-LeRC and by EPRI, which selected several concepts for detailed conceptual design for utility peaking power applications. This project examines technical and economic factors of thermal energy transport to off-site customers, in combination with the extraction and storage concepts of the paralleled study. The four tasks of the project are; (1) identification of applications; (2) technical and economic study of concepts; (3) determination of benefits; and (4) development program recommendations. A literature survey of current and forecast energy consumption as process steam or direct heat in the industrial, commercial, and residential sectors has collected relevant reports. Total market in the temperature ranges applicable to the storage and transport media being considered is being estimated. Technical and economic study of concepts - considers extraction of thermal energy from conventional coal and nuclear plants. The transport media examined include high temperature water (HTW) at temperatures up to 200°C, hot oil to 260°C, and molten salt (e.g., HITEC) to 460°C. Steam is also considered to test the advantage of latent heat availability versus low specific volume. Cost data on the cost elements of thermal transport have been collected, and design and cost equations formulated.

3121 (CONF-781231—, pp 315-326) **Applications of thermal energy storage to process heat storage and recovery in the paper and pulp industry.** Carr, J.H. (Boeing Engineering and Construction Co., Seattle, WA). 1979.

From 3. annual thermal energy storage contractor's information exchange meeting; Springfield, VA, USA (5 Dec 1978).

The project's objective is to determine the impact of thermal energy storage (TES) on energy usage and economics in the paper and pulp industry. The study has been completed and the final report distributed (report is numbered CONS/5082-1 and NASA CR 159398).

3122 (CONF-781231—, pp 327331) **Applications of thermal energy storage to process heat and waste heat recovery in the iron and steel industry.** Katter, L.B.; Peterson, D.J. (Rocket Research Co., Redmond, WA). 1979.

From 3. annual thermal energy storage contractor's information exchange meeting; Springfield, VA, USA (5 Dec 1978).

The system operates from the primary arc furnace evacuation system as a heat source. Energy from the fume stream is stored as sensible energy in a solid medium (packed bed). A steam-driven turbine is arranged to generate power for peak shaving (either internal company load peaks or utility area demand peaks can be smoothed with the system). A parametric design approach is presented since the overall system design, at optimum payback, is strongly dependent upon the nature of the electric pricing structure. Results of this program are reported in CONS/5081-1 issued October 1978.

3123 (CONF-781231—, pp 333-339) **Applications of thermal energy storage in the cement industry.** Jaeger, F.A.; Beshore, D.G.; Miller, F.M. (Martin Marietta Aerospace, Denver, CO). 1979.

From 3. annual thermal energy storage contractor's information exchange meeting; Springfield, VA, USA (5 Dec 1978).

The project includes a definition of the energy consumption by process; sources of waste heat; the amount, quality, and potential for recovery of that heat; and the in-process uses of stored thermal energy in the cement industry. Various energy storage systems and applications were compared. The most promising was selected for further technical and economic analyses. As a result of these analyses, a technology validation program and program plan were developed.

3124 (CONF-781231—, pp 375-383) **Development of operational chemical cycles for the storage of energy.** Wentworth, W.E. (Univ. of Houston, TX). 1979.

From 3. annual thermal energy storage contractor's information exchange meeting; Springfield, VA, USA (5 Dec 1978).

The project's goals are to identify, develop, and demonstrate a chemical reaction cycle for thermal energy storage and regeneration in the temperature range of 400 to 500°C. The proposed cycle is based on the net thermal decomposition of ammonium hydrogen sulfate (NH_4HSO_4). Two reaction mechanisms have been identified which are equivalent to the net thermal decomposition of NH_4HSO_4 and which allow separation of NH_3 and H_2O from the sulfur oxide product at high temperature by formation of an intermediate compound. Twenty-four different intermediate formers have been screened. Nine have been selected for detailed experimental evaluation. The energy regeneration reaction has been investigated and temperatures in excess of 400°C have been achieved. A bench scale flow reactor has been designed and is now operational. The unit is being used to study the energy storage reactions identified as promising. A conceptual NH_4HSO_4/cogeneration cycle has been developed, costed, and performance is being calculated. Optical and thermal analyses of parabolic dish solar collector systems have been completed. Experiments to study the effect of high temperature on solar components are being formulated. A preliminary economic analysis of the NH_4HSO_4 storage system and solar component cost has been made.

3125 (ORNL/MIT—286) **Heat transfer characteristics of phase-changing materials.** Makarewicz, M.A.; Cheng, W.C.; Nwalor, J.U. (Oak Ridge National Lab., TN (USA)). 23 Feb 1979. Contract W-7405-ENG-26. 41p. Dep. NTIS, PC A03/MF A01.

Experimental melting rate and temperature distribution data were obtained for n-octadecane under conduction and natural-convection conditions. Results were in qualitative agreement with theoretical predictions; however, the experimental melting rate exceeded the predicted value by about 20% in the former case. When free convection was the predominant mode of heat transfer, the bulk liquid temperature and the melting rate were constant throughout the process.

CHEMICAL

3126 (CONF-781231—, pp 341-355) **Thermochemical energy storage and transport overview.** Wilson, W.G. (Sandia Labs., Livermore, CA). 1979.

From 3. annual thermal energy storage contractor's information exchange meeting; Springfield, VA, USA (5 Dec 1978).

Under the DOE's program to decentralize the implementation of its Energy Technology policy to field offices and national laboratories, Sandia Laboratories, Livermore, has been assigned program management responsibilities for the Thermochemical Energy Storage and Transport (TEST) Program. The TEST Program investigates reversible thermochemical reaction technologies as they apply to the storage and movement of thermal energy. All classes of reactions are considered with the exception of hydrogen generating and photochemical reactions. The objective of the program is to initiate and develop those concepts and reactions couples which can provide commercially viable solutions to energy storage and transport problems at the earliest possible date.

3127 (CONF-781231—, pp 415-423) **Sulfuric acid and water chemical heat/pump thermal energy storage.** Clark, E.C. (Rocket Research Co., Redmond, WA). 1979.

From 3. annual thermal energy storage contractor's information exchange meeting; Springfield, VA, USA (5 Dec 1978).

A chemical heat pump/thermal energy storage system has been designed, fabricated, and successfully tested under US Department of Energy (DOE)/Sandia funding. This first operational chemical heat pump is a key milestone in DOE's long-term thermal energy storage goals. The sulfuric acid/water chemical heat pump is suitable for both heating and cooling with COP's > 1 possible and has an inherent energy storage capacity up to 600 Btu/lbm. Long-term storage appears promising for this system because the chemicals are stored at ambient temperature and are inexpensive. Moreover, temperatures required for charging (150 to 400°F or 66 to 200°C) are suitable for low-cost solar collectors; and both the mass and volumetric energy storage densities are considerably higher than alternatives such as ice or hot water storage.

3128 (CONF-781231—, pp 433-441) **Development of ammoniated salts, thermochemical energy storage system. Phase II.** Jaeger, F.A.; Haas,W. R. (Martin Marietta Aerospace, Denver, CO). 1979.

From 3. annual thermal energy storage contractor's information exchange meeting; Springfield, VA, USA (5 Dec 1978).

The program is a follow-on to a contract with the Division of Energy Storage in which ammoniated salt systems were studied as potential storage systems for electric power generation plants. The results of that program indicated that the ammoniated salt systems might be better used in lower temperature applications (i.e., residential heating and cooling). Therefore, this phase is concerned with systems that can be used as heat pump/storage systems with either solar or low temperature waste heat as the energy source. The major objective of the program is to determine the feasibility of using systems with ammonium chloride in the low temperature reactor and either manganese or magnesium chloride in the high-temperature reactor as a residential heat pump/thermal storage system.

3129 (CONF-781231—, pp 443-450) **Development of a long-life high-temperature catalyst for the SO_2/SO_3 energy storage system.** Schmidt, E.W. (Rocket Research Co., Redmond, WA). 1979.

From 3. annual thermal energy storage contractor's information exchange meeting; Springfield, VA, USA (5 Dec 1978).

The project's goals are to develop a catalyst which catalyzes the exothermic oxidation of sulfur dioxide and the endothermic dissociation of sulfur trioxide at temperatures up to 1144°K. The material should not be volatile and should retain its activity after exposure to 1144°K for up to ten years. (TFD)

3130 (CONF-781231—, pp 450A-458) **Sandia Laboratories in-house research for the thermochemical energy storage and transport program.** Mar, R.W. (Sandia Labs., Livermore, CA). 1979.

From 3. annual thermal energy storage contractor's information exchange meeting; Springfield, VA, USA (5 Dec 1978).

The Sandia in-house research is intended to augment and complement the contracted portions of the program. Research topics are selected to maintain technical expertise, to study problems generic to several projects, and to perform confirming investigations where the results are controversial. Research has been performed in the following areas: thermochemical/thermophysical characterization, coordination chemistry, corrosion research and catalyst research. An apparatus for making static vapor pressure measurements from room temperature to 573°K has been assembled. The dissociation pressures of several reactions have been experimentally determined with this equipment to complement the sparse data in the literature. A corrosion research program has been initiated. Immersion tests are underway in which candidate alloys are being heated for extended periods of time in a chemical environment; they will be examined by metallographic techniques. Catalyst reaction mechanisms are being studied by infrared techniques. Apparatus has been designed and fabricated which allows in situ catalyst preparation, degassing, and purification of the catalyst under vacuum, and independent monitoring of gas phase and surface species by infrared techniques.

3131 (CONF-781231—, pp 459-465) **Transmission of energy by open loop chemical energy pipelines.** Baker, N.R. (Institute of Gas Technology, Chicago, IL). 1979.

From 3. annual thermal energy storage contractor's information exchange meeting; Springfield, VA, USA (5 Dec 1978).

The final report for this project was published in June 1978. In the open loop pipeline concept, hydrocarbons are supplied at a heat source with both heat and substitute natural gas being the products at an end-use site. The study looked at an HTGR supplying heat for steam reforming, a coal gasification plant producing carbon monoxide and hydrogen, and an HTGR supplied with hydrocarbons by an LNG terminal. The major conclusions drawn are that the open loop chemical energy pipeline is technically feasible, existing natural gas transmission systems could be used, transmission of coal synthesis gases over long distances is more economically attractive than shipment of coal by rail and ample markets exist for the process steam electricity and SNG produced from the system. Product prices calculatd for the coal gasification case may be competitive currently and would almost certainly be attractive in the near future. The HTGR design did not produce product prices competitive in the near future but the coupling of the HTGR with LNG could be viable in the 1980 to 1990 time frame.

BATTERIES

REFER ALSO TO CITATION(S) 3292

DESIGN AND DEVELOPMENT

REFER ALSO TO CITATION(S) 2759, 3144, 3149

3132 (EPRI-EM—1116) **Sodium-sulfur battery supporting R and D: an evaluation of an alternative electrolyte and battery price. Final report, January 1977-June 1978.** Wicker, A.; Pompon, J.P. (Compagnie Generale d'Electricite (CGE), 91 - Marcoussis (France)). Jul 1979. 140p. Dep. NTIS, PC A07/MF A01.

This project has the broad objectives of developing materials and assessing costs of the sodium-sulfur battery. During this phase of the project costs of two cell design alternatives were compared, a new electrolyte was investigated, and electrolyte tubes were fabicated and delivered to EPRI. The fabicating of electrolyte tubes is not covered in the report. The first major objective of this study was to evaluate performance and cost of sodium-sulfur cells. These cells use a beta alumina electrolyte tube to separate the active materials, sodium and sulfur. In one design approach sulfur is contained inside the electrolyte tube and sodium surrounds the tube, in the other approach the location of sulfur and sodium are reversed. The study evaluates the former approach and compares the results with an earlier study (RP726-1) in which the latter approach is evaluated. Cells, modules, and units for a 100 MWh load-leveling battery were designed and costs were estimated on the basis of production of 25 units/year. Particular attention was paid to reliability, safety, and heat transfer and recovery. Efficiency will be a minimum of 75.2%. Installed cost will be $53 (1976)/kWh, as compared with $41 (1976)/kWh the sulfur outside configuration case. The second major objective was to evaluate the fabrication process and properties of the new solid electrolyte $Na_3Zr_2Si_2PO_{12}$ (NASICON). Helium leak-tight tubes with a resistivity of about 5 Ω cm at 300°C were made. Sintering occurs at 1280°C, without any buffering atmosphere. A phase transformation, at 280°C, did not allow the manufacturing of an electrochemical cell that could stand thermal shocks. The high cost of raw materials seemed to cancel the benefit of low-cost sintering. 47 figures, 17 tables.

3133 (INKA-Conf—79-072-004) **Li-Al/CrO/sub x/: a secondary organic electrolyte cell.** Besenhard, J.O. (Technische Univ. Muenchen (Germany, F.R.). Anorganisch-Chemisches Lab.). 1979. 12p. (CONF-7904103—2). Dep. NTIS (US Sales Only), PC A02/MF A01.

From 3. EUCHEM-conference on solid state chemistry and electrochemistry; Endorf, F.R. Germany (30 Apr 1979).

Chromium oxides CrO/sub x/ with $2 < x < 3$ have already been shown to behave well as high-energy-density secondary cathodes in organic Li^+ electrolytes. Unfortunately, metallic Li cannot be used as a secondary negative mass because Li deposits from organic electrolytes are very dendritic and passivate quickly. This problem can be overcome by Li-Al alloy electrodes, which show high cycling efficiency and good wet-stand behavior. Results from cycling and storage of CrO/sub x/ and Li-Al electrodes are very promising, and indicate the feasibility of a low-rate room-temperature secondary cell and an energy density of 650 Wh kg^{-1} based on the electrode materials. 6 figures.

3134 (UCRL—82497(Rev.2)) **Aluminum-air power-cell system design.** Homsy, R.V. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 4 Oct 1979. Contract W-7405-ENG-48. 6p. (CONF-790759—2(Rev.2)). Dep. NTIS, PC A02/MF A01.

From 1. international workshop on reactive metal-air batteries; Bonn, F.R. Germany (9 Jul 1979).

The reaction of Al with water and air in NaOH electrolyte is an electro-chemical system being developed as a possible source of automobile propulsion. The Al-air cell is a small part of a large power-cell system. In addition to concerns of reactant supply and product removal, various separation and thermal-management problems in the overall system must be solved. Five subsystems support the operation of the Al-air cell: air, electrolyte, hydrargillite, water, and coolant. A computer program was written to calculate the flowrate, chemical composition, and temperature of each stream. Four parameters (oxygen stoichiometric factor, current density, temperature of entering air, and temperature of crystallizer for $Al(OH)_3$

were varied to measure system response, and the results are presented. 5 figures, 2 tables. (RWR)

3135 Storage battery. Kumner, J.T. (to Ford Motor Co.). US Patent 4,160,068. 3 Jul 1979. Filed date 21 Nov 1978. 8p.

A high-power, low-total-energy storage battery is disclosed. The basic portion of the battery is a honeycomb separator which defines a plurality of rather small compartments. Alternate compartments throughout the separator are made to be anode compartments or cathode compartments by inserting electrodes, electrolyte, and electrochemical materials in the various compartments. A preferred honeycomb separator is the honeycomb structure used as a support for an automotive exhaust catalyst.

3136 Electrochemical cell with calcium anode. Cooper, J.F.; Hosmer, P.K.; Kelly, B.E. (to Dept. of Energy). US Patent 4,154,903. 15 May 1979. Filed date 17 May 1978. 4p.

PAT-APPL-906,817.

An electrochemical cell comprises a calcium anode and a suitable cathode in an alkaline electrolyte consisting essentially of an aqueous solution of an hydroxide and a chloride. Specifically disclosed is a mechanically rechargeable calcium/air fuel cell with an aqueous NaOH/NaCl electrolyte. 4 figures.

3137 Rechargeable electrochemical system. Appleby, A.J.; Jacquelin, J. (to Compagnie Generale d'Electricite). US Patent 4,139,679. 13 Feb 1979. Priority date 3 Dec 1976, France, 6p.

The invention relates to a rechargeable electrochemical system suitable for use in an electric vehicle. It comprises a battery comprising at least one positive electrode depolarized by air, at least one negative collector, a tank, an electrolyzer comprising at least one positive electrode and one negative electrode, and an electrolyte bearing in suspension the negative active material. The electrolyte is caused to flow either between the tank and the battery or between the electrolyzer and the tank, wherein the total volume of the alkaline electrolyte, bearing in suspension a negative active material containing 250 g to 350 g per liter of equivalent zinc, lies between one and a half and three times the internal volume of the electrolyzer. 6 figures.

PERFORMANCE AND TESTING

3138 (LA—7270-C, pp 38-40) **Batteries - an overview of the state of the art.** McBreen, J. (Brookhaven National Lab., Upton, NY). Jul 1978.

From Fuel cell powered vehicle workshop; Los Alamos, NM, USA (15 Aug 1977).

Secondary batteries being developed are listed. Desirable battery attributes and performace characteristics are given. The requirements of particular importance for electric vehicles are reviewed; durability has often been the most elusive characteristic. Tables give a performance summary for batteries for vehicle propulsion, sources of performance and life-limiting factors in batteries, and the cycle life of Pb/acid and Zn/NiOOH batteries. Specific power is plotted vs specific energy for various batteries. 1 figure, 4 tables. (RWR)

3139 (SAND—79-0869C) **Lithium battery storage and discharge tests.** Levy, S.C. (Sandia Labs., Albuquerque, NM (USA)). 1979. Contract EY-76-C-04-0789. 10p. (CONF-791017—10). Dep. NTIS, PC A02/MF A01.

From 7. international conference on chemical vapor deposition; Los Angeles, CA, USA (14 Oct 1979).

A six-year storage and discharge test of ambient-temperature lithium batteries was initiated. Lithium-sulfur dioxide cells from three manufacturers and lithium polycarbon monofluoride cells from a fourth manufacturer are included. Capacity versus rate and temperature, storage versus temperature and discharge at constant and pulsed loads are being studied. Two problems were identified which will prevent cells from operating continuously for five years. They are corrosion of the glass in the glass-to-metal seal and corrosion of the anode-to-can contact. In addition, cells exposed to high-temperature storage experienced corrosion of the aluminum-to-tantalum weld in the positive lead. 15 figures.

MATERIALS, COMPONENTS, AND AUXILIARIES

REFER ALSO TO CITATION(S) 3132

3140 (INKA-Conf—79-072-001) **Electrochemical behavior of metallic oxides.** Brenet, J.P. (Strasbourg-1 Univ., 67 (France)). 1979. 12p. (In German). (CONF-7904103—4). Dep. NTIS (US Sales Only), PC A02/MF A01.

From 3. EUCHEM-conference on solid state chemistry and electrochemistry; Endorf, F.R. Germany (30 Apr 1979).

The oxides most frequently investigated to date are surveyed, and some physicochemical properties of the oxides of interest for electrochemistry are given. The problem of electrochemical reactivity is considered and data on some electrochemically active metallic oxides are discussed.

3141 Offset perforated lead-acid battery grid. Hug, L.F.; Uba, T.; Frazier, C.; Varga, J.F. (to The Gates Rubber Co.). US Patent 4,151,331. 24 Apr 1979. Filed date 23 Feb 1978. 6p.

A grid for a lead-acid battery is disclosed which has a network of integrally interconnected strands of lead in which a portion of the strands are offset and project from one face of the grid while a second portion of the strands porject and are offset to the other opposed face of the grid, to form upstanding projections and alternating depressions. The grids are useful as current collector substrates in Faure plates. 10 figures.

3142 Positive nickel electrode for alkaline storage batteries and process for its production. Saridakis, N. (to Volkswagenwerk Aktiengesellschaft). US Patent 4,160,047. 3 Jul 1979. Priority date 9 Jul 1977, German, Federal Republic of (F.R. Germany), 4p.

A positive nickel electrode for alkaline storage batteries is formed to contain aluminum hydroxide. A porous supporting grid of conducting material is immersed in an impregnating solution containing a nickel salt dissolved in a solvent and at least one aluminum salt in solution. The grid is subsequently immersed in an alkaline medium where the hydroxides are precipitated.

3143 Alkali metal containing battery grid lead alloy. Vikram Rao, M.; Foerster, G.S.; Hebbar, R.K. (to NL Industries, Inc.). US Patent 4,159,908. 3 Jul 1979. Filed date 14 Aug 1978. 6p.

A lead alloy containing alkali metal and with low antimony content, characterized by improved ductility for use as an electric storage battery grid or in acidic environments, suitably contains from 0.5% to 3.0% Sb, 0.01% to 0.7% As, 0.001% to 0.7% Sn, 0.001% to 0.15% Cu, 0.001% to 0.015% S or 0.001% to 0.05% Se or admixtures thereof, and 0.001% to 0.05% of an alkali metal. Battery grids made from the alloy are resistant to electrochemical corrosion, gassing, and grid growth, and exhibit improved bend ductility. 3 tables.

3144 Hydrogen electrochemical cell and rechargeable metal-hydrogen battery. Berchielli, A.S.; Chireau, R.F. (to Yardney Electric Corp.). US Patent 4,159,367. 26 Jun 1979. Filed date 29 Jun 1978. 10p.

An improved hydrogen electrode comprises a porous sheet of carbon particles catalyzed by platinum or palladium and bonded together with a hydrophobic binder, preferably Teflon, so that the sheet is wetproofed. A conductive metallic screen coated on one side with a hydrophobic binder is laminated on the coated side to the sheet. A battery comprising a stack of the improved hydrogen electrodes, preferably with conductive metallic spacers between the screen of each cell and the cathode of the next adjacent cell forming a bipolar duplex electrode with hydrogen flow passageways to the screen-covered face of each anode, is stacked together with an electrolyte-filled separator provided between the bipolar electrodes. The improved hydrogen anode is the anode of the duplex electrode, while the cathode of the duplex electrode may be a material such as a porous sintered nickel or silver plaque. The conductive means joining the anode and cathode comprises the metallic screen with or without the metallic spacer present.

3145 Dual voltage, dual battery charging system. Kofink, W. US Patent 4,156,171. 22 May 1979. Priority date 9 Oct 1976, German, Federal Republic of (F.R. Germany), 6p.

To provide for automatic charging of two batteries which are series connected, particularly to supply the on-board network of an automotive vehicle from a main battery and to supply additional higher surge voltage output to the vehicle starter, a three-phase alternator has output rectifiers connected to two phases, and the rectifier to the main battery, the third phase with its rectifier being connected to the auxiliary battery. The third phase rectifier may, instead of diodes, include a diode-transistor combination, the transistor being controlled by voltage of the second battery selectively to charge the second battery or connect the third phase for charging of the main battery. The phase windings of the alternator may all be identical, the lighter loading of the phase connected to the additional battery providing the higher output voltage required. 3 figures.

3146 Electrode configuration for alkaline battery systems. Menard, C.J. (to Gould Inc.). US Patent 4,154,908. 15 May 1979. Filed date 21 Jun 1978. 14p.

A secondary alkaline system, such as, for example, nickel-zinc, characterized by improved cycle life and superior volumetric energy density is provided in which the negative electrodes comprise a flat central portion with edges which have a greater amount of active material than does the central portion and positive electrodes have a flat central portion of substantially the same size as that of the negative electrode with edges having less active material than the central portion. In the preferred embodiment, the greater amount of active material at the edges is achieved in the negative electrodes by providing flared edges, and the lesser amount in the

edges of the positive electrodes is obtained by forming the electrode with tapered edges. 14 figures, 3 tables.

3147 Side terminal battery structure. Crow, J.V. (to General Motors Corp.). US Patent 4,154,907. 15 May 1979. Filed date 14 Nov 1977. 4p.

A leakproof, side-terminal battery of the thin-wall type comprises a terminal insert formed by injection molding a thermoplastic body about a conductive spool, which insert is mated with an aperture in the battery case wall and welded to a boss surrounding the aperture. The body includes a plug portion for insertion into the aperture and a flange portion for welding to the boss. The conductive spool preferably includes an extension projecting into the battery for fusing to the battery's innards at a location remote from the wall. 6 figures.

3148 Storage battery attachment. Michael, F.R. US Patent 4,154,904. 15 May 1979. Filed date 9 Sep 1977. 6p.

This invention is an attachment for a standard storage battery attachment providing a liquid reservoir which is in communication with the individual cells of the battery for automatically maintaining a predetermined electrolytic level within the individual cells while simultaneously allowing gas buildup to be released. A valve is located between each cell and the reservoir. The valve opens and closes in response to the electrolytic level within the cell to automatically maintain the electrolyte at a predetermined level. The attachment is provided with a cover having one or more openings for adding liquid to the reservoir. 10 figures.

3149 Battery cell connecting device. Jenzano, J.J. US Patent 4,155,000. 15 May 1979. Filed date 9 Nov 1977. 4p.

An apparatus for use in connecting adjacent cells of storage batteries electrically and mechanically is described. Passing an electric current through electrical resistance elements causes a rapid heating of the elements and of the battery terminal parts contacting them. 10 figures.

3150 Device for determining the charge condition for a secondary electric storage battery. Jungfer, L.; Kautschitsch, D.; Weber, R. (to Akkumulatoren-fabrik Dr. Leopold Jungfer). US Patent 4,153,867. 8 May 1979. Priority date 16 Nov 1976, Austria, 6p.

A device for determining the charge condition of a secondary electric storage battery includes a digital integrator comprising a pulse generator for producing pulses at a frequency proportional to the magnitude of the instantaneous battery current and an up-down counter for counting the pulses in a sense (i.e., up or down) dependent upon the battery current direction. A switching arrangement operates to couple selectively the pulse generator or an adjustment pulse generator to the counter, and a comparator controls the supply of pules to, and the sense of counting in, the counter when the adjustment pulse generator is coupled to it in accordance with the result of a comparison of the counter setting and of a function signal. A function generator, programable in accord with the relationship between temperature, no-load voltage, and charge condition of the battery concerned, is controllable in accord with the instantaneous temperature and no-load voltage of the battery so as to generate the function signal to represent the associated charge condition. 1 figure.

3151 Storage battery, separator therefor and method of formation. Murata, K.; Tanso, S.; Yamao, J. (to Yuasa Battery Co. Ltd.). US Patent 4,153,759. 8 May 1979. Priority date 11 Jul 1974, Japan, 8p.

The present invention relates to a high-performance lead-acid storage battery having a special microporous separator between a positive and a negative plate in a cell of the battery. The separator is comprised of a microporous embossed thin sheet having many small projecting embossed parts which provides unique characteristics in a cell including low electric internal resistance in the cell, sufficient electrolyte between the plates in the cell, and sufficient elasticity of the separator to prevent active material shedding. A high performance at a high rate of discharge and long life thereby results. 12 figures.

3152 Method for preventing dendritic growth in secondary cells. Schlaikjer, C.R. (to P. R. Malloyr and Co. Inc.). US Patent 4,139,680. 13 Feb 1979. Filed date 9 Mar 1977. 6p.

A high-conductivity stable clovoborate electrolyte salt is used in alkali and alkaline earth metal nonaqueous secondary cells to prevent dendritic formation of the plated alkali or alkaline earth metal. 2 tables.

3153 Electrochemical cells having alkali metal anodes and electrolyte salt complex compositions including haloorganometallic alkali metal salt complexes. Klemann, L.P.; Newman, G.H.; Stogryn, E.L. (to Exxon Research and Engineering Co.). US Patent 4,139,681. 13 Feb 1979. Filed date 2 Mar 1978. 20p.

Electrochemical cells having alkali metal anodes, e.g., lithium batteries, are described which contain electrolytically active alkali metal salt complexes including haloorganometallic alkali metal salt complexes having the formula ZMR/sub n/K/sub i/, wherein Z is an alkali metal, M is a metal selected from the group consisting of Zn, Cd, B, Al, Ga, In, Tl, Sn (stannous), P and As, the Rs are specified haloorganic radicals, the Xs are selected from various halides, alkyls, aryls, alkaryls, and aralkyls, and n and i are numerical values the sum of which is equal to one plus the valence of the metal M, subject to the proviso that, if n is zero, at least one X is an organic radical. Rechargeable, high-energy-density electrochemical cells containing an anode having an alkali metal as its active material, a cathode having as its active material a transition metal chalcogenide, and in electrolyte composition of the above-described type are also described. 7 tables.

3154 Battery charge detector and charging system including such detector. Smith, S.B. (to Lucas Industries Ltd.). US Patent 4,137,493. 30 Jan 1979. Priority date 8 Nov 1975, United Kingdom of Great Britain and Northern Ireland (UK), 6p.

A detector, intended particularly for detecting end of charge of a secondary battery under constant current charge, includes a linear input stage producing an output voltage linearly related to the battery voltage. A relay contact is closed periodically by pulses from a clock to connect the output of the input stage to a capacitor and resistor in series. Any change in the output voltage between closure of the contact cause current to flow in the resistor, and a comparator compares the voltage across this resistor with a reference voltage. When the battery is charged and the output voltage starts to fall, the negative voltage on the resistor cause the comprator to latch and provide an output signal. 1 figure.

APPLICATIONS

REFER ALSO TO CITATION(S) 3138, 3306, 3307

ENERGY MANAGEMENT AND POLICY

REFER ALSO TO CITATION(S) 3301

ENERGY ANALYSIS AND MODELING

REFER ALSO TO CITATION(S) 3163, 3190, 3203, 3279, 3280, 3593

3155 (DOE/EIA/8560—1) Regional Demand Forecasting Model: 1977 and 1978 versions. Task 3, final documentation report. Parhizgari, A.M. (Synergy, Inc., Washington, DC (USA)). 25 Sep 1978. Contract EM-77-C-01-8560. 137p. Dep. NTIS, PC A07/MF A01.

This report documents the demand forecasting model, RDFOR. Chapter I presents an overview of the structure of RDFOR as well as its linkages with other models within the PIES model. An important link between RDFOR and PIES is the Demand Interface System (DFACE) which prepares the output of RDFOR for input into PIES. Chapter II provides an in-depth analysis of the data bases used in the estimation and simulation of RDFOR. It presents an analysis of trends in energy data by fuel and by sector for both the United States as a whole and for each of the 10 DOE Regions. Chapter III provides a detailed analysis of the theoretical structure of RDFOR, analyzes a transportation sector model and a minor fuels sector model which differ in structure from the other sectors within RDFOR, and examines the econometric implementation of RDFOR. Chapter IV describes the simulation of RDFOR and its resultant forecasts. Emphasis is placed on the various restrictions and transformations performed prior to and during the simulation. A description of scenario implementation is also included. An analysis of the changes made in the simulation equations from the specification of the estimation equations is an important part of this chapter.

3156 (NP—24136) Systems analysis of technological response factors. Bauerschmidt, R. (Hannover Univ. (Germany, F.R.). Fakultaet fuer Maschinenwesen). 1978. 191p. (In German). Dep. NTIS (US Sales Only), PC A09/MF A01.

This study summarizes the technological application factors (e.g., energy, work, material) in a widely entwined economic structure. An energy demand model based on the results of this investigation was designed from which the development until the year 2000 can be estimated. Starting from the final demand for goods and services the production requirements for all sectors of free enterprise were derived considering intersectoral entanglements and, eventually, the energy demand.

ECONOMICS AND SOCIOLOGY

REFER ALSO TO CITATION(S) 2482, 2484, 3156, 3183, 3186, 3189, 3616

3157 (COO—4913-1) **Colloquy and workshops: regional implications of the engineering manpower requirements of the National Energy Program.** Segool, H.D. (ed.). (Massachusetts Univ., Amherst (USA). School of Engineering). May 1979. Contract EU-78-C-02-4913. 212p. (CONF-790386—). Dep. NTIS, PC A10/MF A01.

From A colloquy and workshops: regional implications of the engineering manpower requirements of the national energy program; Amherst, MA, USA (1 Mar 1979).

The crucial interrelationships of engineering manpower, technological innovation, productivity and capital re-formaton were keynoted. Near-term, a study has indicated a much larger New England energy demand-reduction/economic/market potential, with a probably larger engineering manpower requirement, for energy-conservation measures characterized by technological innovation and cost-effective capital services than for alternative energy-supply measures. Federal, regional, and state energy program responsibilities described a wide-ranging panorama of activities among many possible energy options which conveyed much endeavor without identifiable engineering manpower demand coefficients. Similarly, engineering manpower assessment data was described as uneven and unfocused to the energy program at the national level, disaggregated data as non-existent at the regional/state levels, although some qualitative inferences were drawn. A separate abstract was prepared for each of the 16 individual presentations for the DOE Energy Data Base (EDB); 14 of these were selected for Energy Abstracts for Policy Analysis (EAPA) and 2 for Energy Research Abstracts (ERA).

3158 (COO—4913-1, pp 63-72) **Demand/supply prospectus for energy-related engineering manpower.** Seltzer, N. (Dept. of Energy, Washington, DC). May 1979.

From A colloquy and workshops: regional implications of the engineering manpower requirements of the national energy program; Amherst, MA, USA (1 Mar 1979).

The Department of Energy's Manpower Assessment draws information from other government and non-government sources doing its own studies when necessary. In its most recent occupational outlook forecasts, the Bureau of Labor Statistics anticipates that there will be more than 1.4 million enginering jobs by 1985, an increase of 25% over the 1976 level. Through 1981 there will be an excess of demand for graduating engineers over supply. The energy engineering workforce is growing. More of the new entrants into engineering report they are in energy related work than does the experienced workforce. As energy-related engineers are more likely to be in private industry, their medium salary was 6% higher than for non-energy engineers. In analyzing the nuclear industry, nuclear engineering employment has shifted from the public to the private sector, paralleling nuclear energy's development from research and development to commercialization.

3159 (DOE/EIA—0184/15) **Historical and forecasted energy prices by DOE Region and fuel type for three macroeconomic scenarios. Analysis report AR/EU/79-39.** (Department of Energy, Washington, DC (USA). Energy Information Administration). Jul 1979. 83p. Dep. NTIS, PC A05/MF A01.

This memorandum reports: historical fuel prices for 1977; updated energy price forecasts for 1985, 1990, and 1995 under three sets of macroeconomic assumptions; and annual growth rates for the periods 1977-1985, 1985-1990, and 1990-1995. Detailed projections are shown for the Nation and each Federal Administrative Region, each end-use sector (residential, commercial, industrial, and transportation); each energy source (electricity, natural gas, petroleum, and coal, as appropriate); and each of three macroeconomic scenarios representing alternative futures. The first section provides the current assumptions and methodology employed in projecting the energy prices. The second section provides the updated results, and the appendix presents detailed data with regard to the assumptions that underlie the three scenarios postulated. (MCW)

3160 (DOE/EIA/10496—1) **Taxonomy of energy taxes.** (National Academy of Sciences, Washington, DC (USA)). Sep 1979. Contract AC01-79EI10496. 48p. Dep. NTIS, PC A03/MF A01.

This report provides the US DOE with a taxonomy of the direct Federal, state, and local taxes that differentially affect energy markets, including features of general taxes that affect energy differentially; and describes some of the important analytical questions associated with the taxes included in the taxonomy. First, the report discusses energy taxation within the broad context of energy production and use. The second part includes the formal taxonomy and a detailed breakdown of energy taxes by taxing authority and suggests the important issues that are likely to arise in an analysis of energy taxation.

3161 (DOE/EV—0046(Vol.1), pp 1-3) **Plenary session: keynote speaker.** O'Leary, J.F. (Dept. of Energy, Washington, DC). Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

There are plenty of dirty technologies around. We can meet all of our requirements for energy by simply sacrificing air quality, environmental quality generally, and public health and safety considerations. That is not the name of the game that we're involved in at DOE. What we are going to try to do, and quite explicitly rather than implicitly over the next few years, is put in place criteria that will produce technologies that are economic and that are environmentally acceptable. I regard these challenges as the principal role in R and D for the Department of Energy.

3162 (DOE/IR—0035) **Energy and consumer protection, competition, and fraud. Official transcript of public briefing and addendum, March 30, 1978, Washington, D.C.** (Department of Energy, Washington, DC (USA). Office of Consumer Affairs). Oct 1978. 15p. Dep. NTIS, PC A08/MF A01.

Fifty questions are posed dealing with consumer protection, competition, and fraud. Answers are supplied by DOE officers and are additionally discussed at a public briefing on the subject. A transcript of the briefing is included.

3163 (ORNL/CON—37) **Neoclassical theory of durable good diffusion.** Jackson, J.R.; Kaserman, D.L. (Oak Ridge National Lab., TN (USA)). Oct 1979. Contract W-7405-ENG-26. 82p. Dep. NTIS, PC A05/MF A01.

Existing studies that deal with the diffusion of durable good innovations have been justifiably criticized for their common lack of an explicit testable theory of new product growth. This paper attempts to remedy this situation by providing a theoretical model of market penetration of new durable goods that is derived from the basic assumption that potential users of the new intermediate product attempt to minimize the discounted costs of production over time. The resulting model defines a time path of short-run equilibrium market shares that are determined by the cost characteristics (capital cost and operating and maintenance expenses) of both the new innovation and the equipment that it is designed to replace, the age distribution of the existing capital stock, and the growth rate of the adopting sector. This model is shown to exhibit several attractive features lacking in existing models of the diffusion process. First, it yields a number of testable hypotheses, some of which have received indirect empirical support in previous studies on the subject. Second, it is operational in the absence of historical data on the market experience of the new good under investigation. And third, it is capable of generating, on the basis of such ex ante information, the complete range of functional forms used in prior models to represent the relationship between market share and elapsed time since introduction of the new innovation. These features render the model inherently superior to existing studies for the analysis of emerging products and frontier technologies for which market data are not yet available.

3164 **Taxonomy of energy taxes.** Washington, DC; National Academy of Sciences (1979). 49p. (NP—24066). The Publisher, Washington, DC.

This report provides the US Department of Energy with a taxonomy of the direct Federal, state, and local taxes that differentially affect energy markets, including features of general taxes that affect energy differentially; and describes some of the important analytical questions that are associated with the taxes included in the taxonomy. This report does not provide any analysis of those questions, but rather seeks to inform the Department of Energy of what the analytical issues are and how they might be addressed. This first part of the report discusses energy taxation within the broad context of energy production and use. The second part includes the formal taxonomy and a detailed breakdown of energy taxes by taxing authority and suggests the important issues that are likely to arise in an anlysis of energy taxation.

ENVIRONMENT, HEALTH, AND SAFETY

REFER ALSO TO CITATION(S) 2436, 3161, 3191, 3205, 3301, 3581, 3582, 3591, 3593, 3603, 3616, 3671

3165 (DOE/TIC—10263) **Economic impact analysis of constraints on particulate control equipment replacements, R79-3.** Cohen, A.S. (CSI Resource Systems, Inc., Boston, MA (USA)). Jun 1979. Contract W-31-109-ENG-38. 36p. Dep. NTIS, PC A03/MF A01.

The Illinois Environmental Protection Agency (IEPA) submitted amended proposed revisions to Rules 101, 103, and 105 of Chapter 2, Air Pollution Control Regulations, to the Illinois Pollution Control Board (PCB) on March 19, 1979. The Illinois State Chamber of Commerce submitted an alternative proposal on March 23, 1979. The PCB issued an interim order to amend these rules on

March 29, 1979. The analysis reported in this document focuses on Rule 105(a)(3) as proposed by the IEPA and the Chamber of Commerce. The purpose of the analysis is to satisfy the economic impact statement requirements of Illinois Public Act 79-790. The control strategies considered by the PCB (R79-3) and evaluated in this report are those proposed revisions for Rule 105(a)(3) by the Agency and by the Chamber. The Agency's Proposed Rule 105(a)(3) states: In the following townships, no person shall replace the air-pollution control equipment on any source of particulate matter with a less-effective kind of control equipment (and the areas are listed). The Chamber's proposed Rule 105(a)(3) states: In the following townships, no person shall replace the air-pollution control equipment on any source of particulate matter with a less-effective kind of control equipment, provided, however, that this provision shall not preclude operation of the production facilities or air-pollution control equipment in any manner which does not cause excess emissions as herein defined; and those areas are listed.

NATURAL RESOURCES

REFER ALSO TO CITATION(S) 3190, 3672

3166 (ORNL/TM—6739) **Systematic method for resource rating with two applications to potential wilderness areas.** Voelker, A.H.; Wedow, H.; Oakes, E.; Scheffler, P.K. (Oak Ridge National Lab., TN (USA)). Sep 1979. Contract W-7405-ENG-26. 72p. Dep. NTIS, PC A04/MF A01.

A versatile method was developed to rate the energy- and mineral-resource potentials of areas in which land-management and resource-development decisions must be reached with a minimum expenditure of money and time. The method surveys published and personal information on resources in the region being assessed, selects the most appropriate information, synthesizes the information into map overlays and tract descriptions, rates the potential of tracts for particular resources, rates the overall importance of each tract for resource development, and documents the ratings and their significance. Basic criteria considered by the assessment team include the favorability and certainty ratings, the overall availability of each rated resource within this country, the size of a given tract, economic factors, and the number of resources in a tract. The method was applied to two separate but roughly similar geologic regions, the Idaho-Wyoming-Utah thrust belt and the central Appalachians. Undeveloped tracts of national forestland in these regions that are being considered for possible designation under the Roadless Area Review and Evaluation (RARE II) planning process were rated for their resource value. Results support earlier indications that the 63 tracts comprising the western thrust belt possess a high potential for future resource development. Nearly one-half of these tracts were rated either 3 or 4. However, the wide spread of the importance ratings between 1 and 4 suggests that some tracts or portions of tracts can be added to the National Wilderness System without compromising resource development. The 72 eastern thrust belt tracts were given lower ratings, which indicates the reduced significance of the few remaining roadless areas in this region in satisfying the nation's near-term resource needs.

RESEARCH, DEVELOPMENT, DEMONSTRATION, AND COMMERCIALIZATION

REFER ALSO TO CITATION(S) 3157, 3163, 3192, 3208, 3287

3167 (COO—4913-1, pp 57-61) **Federal initiatives for the commercialization of emerging energy technologies.** Gouraud, J.S. (Dept. of Energy, Washington, DC). May 1979.

From A colloquy and workshops: regional implications of the engineering manpower requirements of the national energy program; Amherst, MA, USA (1 Mar 1979).

The Department of Energy's role in the commercialization of emerging energy technologies is to remove the roadblocks so private industry can move more quickly. During normal times it might be 12 or more years to take a new technology from the laboratory to commercialization. To reduce US dependence on imported oil, new energy technologies must be encouraged by removing any economic, environmental, institutional and technological barriers. The Department of Energy Task Forces have now determined the current readiness of the most promising technologies. Key barriers to commercialization were identified and strategies were written to determine the most effective Government actions.

3168 (HEDL-SA—1826-FP) **Performance Measurement System: recent systems development and applications.** Rigney, R.A. (Hanford Engineering Development Lab., Richland, WA (USA)). 28 Mar 1979. Contract EY-76-C-14-2170. 15p. (CONF-790988—1). Dep. NTIS, PC A02/MF A01.

From 6. internet international Management System Association meeting; Garmisch-Partenkirchen, F.R. Germany (24 Sep 1979).

The Performance Measurement System (PMS), a system for managing a given project or program, is described; this system incorporates the value earned for work accomplished approach. Development and application of this system is discussed under the following headings: PMS vs conventional management control systems; PMS implementation on a project/program; PMS data elements (organization, planning and budgeting, accounting, analysis, reports, and performance measurement data elements); recent PMS applications (FFTF, CRBRP, FMEF, and FMIT); and future of PMS. 25 references, 6 figures, 3 tables. (RWR)

3169 (LBL—9642) **Projects from Federal Region IX: DOE appropriate energy technology pilot program. Part I.** Case, C.W.; Lucarelli, F.B.; Morris, J.; Clark, H.R. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Aug 1979. Contract W-7405-ENG-48. 42p. Dep. NTIS, PC A03/MF A01.

Some pilot programs for appropriate technology projects within Federal Region IX with information on technical and economic data are assembled. In Arizona, the following programs are included: concept testing of an energy management system; solar air active heater/passive cooler collector system; hardware package and workshop curriculum for residential solar hot water systems; Project SAW - solar, adobe, wind; Solar/Adobe Project. The following programs are being conducted in California - two stage evaporative cooler, lompico logs, solar process heating for a bottle-sterilizing plant, solar/woodstove domestic water heating systems, solar-heated greenhouses, and remote-location wind electric system. A small farm and homestead anaerobic digester program is in progress in Hawaii. In Nevada, the following have been funded: solar heating for a rural firehouse; Pyramid Lake solar-assisted fish hatchery; and agua caliente. The following programs in the Western Pacific are being conducted: Satawan health dispensary solar hot water system, Western Pacific solar hot water construction and demonstration, and fishmeal from solar-heated driers. (MCW)

3170 **Exploring new energy choices for California. The 1979/1980 R and D report to the Legislature. Volume I.** Sacramento, CA; California Energy Commission (1979). 101p. (NP—24133).

This report describes the past, present, and proposed research and development activities of the California Energy Commission. The amount of money spent by a California family for support of energy is outlined, and the report provides the Legislature with an account of how the California Energy Commission spends its portion of this money. Chapters are entitled: The Role of Research and Development at the California Energy Commission; The Role of R and D in the Development Program; Highlights of Development Program R and D Activities (solar, fuels, geothermal, and special projects elements); Other Energy Commission R and D (The Energy Conservation Program and The Regulatory and Planning Program). (MCW)

NUCLEAR ENERGY

REFER ALSO TO CITATION(S) 2695, 2997, 3000, 3175, 3182

3171 (NUREG—0567) **Proposed policy and procedures for differing professional opinions: for comment.** Watters, H.J.; Vandenberg, R.L. (Nuclear Regulatory Commission, Washington, DC (USA). Office of Management and Program Analysis). Oct 1979. 15p. NTIS.

It is the policy of the Nuclear Regulatory Commission, and the responsibility of all NRC supervisory and managerial personnel, to maintain a working environment that encourages employees to make known their best professional judgments even though they may differ from a prevailing staff view, disagree with a management decision or policy position, or take issue with established agency practices. Each differing professional opinion of an NRC employee will be evaluated on its own merit. Further, each differing professional opinion will be pursued to resolution and the employee's statement of differing professional opinion, together with the agency's final response, will be made available to the public to ensure the openness of NRC decisions that may affect the public. It is not only the right but the duty of all NRC employees to make known their best professional judgments on any matter relating to the mission of the agency. Moreover, both the general public and the Nuclear Regulatory Commission benefit when the agency seriously considers differing professional opinions held by NRC employees that concern matters related to the agency's mission. This policy assures all employees the opportunity to express differing professional opinions in good faith, to have these opinions heard and considered by NRC management, and to be protected against retaliation in any form. Individual NRC offices may develop procedures to meet

their specific needs. Office procedures must be consistent with agency policy and procedures. Scope, objectives, and procedures are discussed.

3172 **Power politics. The nuclear industry and nuclear exports.** Duffy, G.C.; Adams, G. New York, NY; Council on Economic Priorities (1978). 135p. (CEP-R8—1). Council on Economic Priorities, 84 Fifth Ave., New York, NY 10011.

This report examines the nuclear industry, its involvement in the international nuclear market, and the views of corporate spokespersons on exports and proliferation. It addresses the question of how nonproliferation policy may affect the nuclear industry and the nuclear power debate in the US, and how the status of the industry and trends in the world nuclear market may determine the impact of US nonproliferation policy. It is found that: the major US nuclear companies have acted as de facto international policy makers, due in large part to governmental inaction and delay in clarifying nuclear export policies in recent years. The US nuclear industry's domestic sales crisis has been paralleled by an export crisis. Despite its early promise to promote a nonnuclear world, the Carter Administration's nuclear policy appears to have opted for encouraging the renewed growth of nuclear power at home and abroad, albeit with an effort to apply nuclear safeguards. In disclosures to CEP, nuclear companies indicate a general pessimism about US abilities to restrict both the growth of nuclear power and the spread of nuclear weapons abroad. Washington is giving increasing support to the US nuclear industry's foreign marketing efforts, particularly through the Export-Import Bank. Public data on the size and composition of the domestic and international nuclear markets are virtually unavailable. The nuclear industry responded extremely poorly to CEP requests to disclose corporate data.

TRANSPORT AND STORAGE

REFER ALSO TO CITATION(S) 2456

WASTE HEAT UTILIZATION

REFER ALSO TO CITATION(S) 2924, 3202, 3281, 3295, 3296, 3297

3173 (DOE/EV—0046(Vol.1), pp 272-283) **Impact of cogeneration upon emissions.** Lister, E. (Dept. of Energy, Washington, DC). Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

The objective of this paper is to highlight why an energy conservation technique such as cogeneration is of primary interest to a Fossil Energy group whose major criteria for success is the utilization of coal. The paper will show the following: (1) that cogeneration can reduce the emissions/useful output by a factor of 3 to 5 and is therefore one of the leading technologies for the acceptable utilization of coal and coal-derived fuels; and (2) that if cogeneration based on coal and coal-derived fuels is to become prominent in the industrial and commercial/residential sectors it will require the continual development of (a) heat engines to handle the harmful agents in these fuels, (b) heat recovery equipment so they can be cogenerated, and (c) an on-going effort to identify and develop other critical technologies needed to make coal cogeneration the success that it promises to be. The paper emphasizes current major efforts in these areas.

3174 (DOE-FFU—1703) **Cogeneration: technical concepts, trends, prospects.** (Department of Energy, Washington, DC (USA). Div. of Fossil Fuel Utilization). Sep 1978. 45p. Dep. NTIS, PC A03/MF A01.

In the National Energy Plan, President Carter cited cogeneration as an important technique for conserving domestic energy resources. Cogeneration offers important advantages over conventional approaches in, namely: energy efficiency, fuel flexibility, economics, environment, and power reliability. The basic concepts underlying current and future cogeneration systems, and the types of hardware, fuels, and overall system applications adaptable for use by the different market sectors, are described. Trends in usage are traced and explored, and early cogeneration installations are reviewed to provide insight into the factors underlying those trends. The European experience is compared with the United States experience, and key factors influencing successes and failures are analyzed. Factors that have prompted renewed interest in cogeneration over the past few years are identified, barriers to widespread adoption in all market sectors are discussed, and Federal efforts currently under way to encourage both technological and market development are highlighted in the final section. Brief case studies of cogeneration installations in the various sectors are presented throughout the document to illustrate various aspects of system operation and capabilities. All demonstrate that cogeneration is a viable technological alternative that offers the United States one more strategy for working toward its goal of energy self-sufficiency both now and over the long term. (MCW)

3175 (GA-A—15538) **Analysis of reactor strategies to meet world nuclear energy demands.** Ligon, D.M.; Brogli, R.H. (General Atomic Co., San Diego, CA (USA)). Jul 1979. Contract AT03-76ET35300. 49p. Dep. NTIS, PC A03/MF A01.

A number of reactor deployment strategies for long-term nuclear system development are analyzed from a global perspective in terms of resource utilization and economic benefits. Two time frames are chosen: 1975 - 2025 and 1975 - 2050. Uranium demand for various strategies is compared with uranium supply assuming different production capabilities and resource base. The analysis shows that a given reactor deployment strategy could strongly influence the extent of uranium exploration and production. Power systems cost comparisons are made to identify clearly competitive or noncompetitive reactors. The sensitivity of power cost to different uranium price projections and nuclear demands is also examined. The results indicate that breeders are necessary to support a long-term nuclear power system. Advanced converter-breeder symbiotic systems, particularly those operating on the Th/U-233 cycle, have clear advantages in terms of resources and economics.

CONSERVATION

REFER ALSO TO CITATION(S) 3188, 3262, 3270, 3273, 3281, 3284, 3287, 3294, 3299, 3301

3176 (DOE/CS/2671—2) **Energy extension service pilot program evaluation report: the first year. Volume I: evaluation summary.** (ICF, Inc., Washington, DC (USA); Westat, Inc., Rockville, MD (USA)). Sep 1979. Contract EX-77-C-01-2671. 177p. Dep. NTIS, PC A09/MF A01.

The evaluation report of the Energy Extension Service in the 10 pilot states - Alabama, Connecticut, Michigan, New Mexico, Pennsylvania, Tennessee, Texas, Wyoming, Washington, Wisconsin - contains 8 chapters. Chapter II describes the methodology and Chapter III summarizes the findings. Chapters IV, V, and VI trace the progression from program operations through client impact to energy savings. Chapter VII analyzes the factors that might contribute to making some programs work more effectively than others. The service delivery programs are divided into 3 categories according to the target audience served: residential homeowners and renters, small businesses, and public institutions. Chapter VIII discusses the implications for the National EES Program. (MCW)

3177 (DOE/CS/2671—3) **Energy extension service pilot program evaluation report: the first year. Volume II: pilot state reports.** (ICF, Inc., Washington, DC (USA); Westat, Inc., Rockville, MD (USA)). Sep 1979. Contract EX-77-C-01-2671. 638p. Dep. NTIS, PC A99/MF A01.

Volume II of the Energy Extension Service Evaluation presents a discussion of the operations of the ten EES pilot-state programs during the period from October 1, 1977 through September 30, 1978. Each of the ten pilot states - Alabama, Connecticut, Michigan, New Mexico, Pennsylvania, Tennessee, Texas, Washington, Wisconsin, and Wyoming - received a grant of approximately $1.1 million to develop and implement a 19-month program beginning on October 1, 1977. Volume II provides a case-study description of the operations of the pilot program in each state, with special attention given to the two programs selected in each state for more detailed study and survey research. Some survey data and analysis are presented for the emphasis programs.

3178 (DOE/CS/2671—4) **Energy extension service pilot program evaluation report: the first year. Volume III: supplementary reports.** (ICF, Inc., Washington, DC (USA); Westat, Inc., Rockville, MD (USA)). Sep 1979. Contract EX-77-C-01-2671. 277p. Dep. NTIS, PC A13/MF A01.

The appendices presented in this volume support and supplement Volume I of the Energy Extension Service Pilot Program Evaluation Report: The First Year. The appendices contain back-up data and detailed information on energy savings estimation and other analytic procedures. This volume also describes the data sources used for the evaluation. Appendix I presents the Btu estimation procedures used to calculate state-by-state energy savings. Appendix II contains details of the data sources used for the evaluation. Appendix III presents program activity data, budget, and cost per client analyses. Appendix IV, the Multivariate Analysis of EES Survey Data, provides the basis for the Integrating Statistical Analyses. Appendix V describes the rationale and exclusion rules for outlying data points. The final appendix presents program-by-program fuel costs and self-reported savings and investment.

3179 (DOE/EDP—0041) **Environmental Development Plan buildings and community systems.** (Department of Energy, Washing-

ton, DC (USA). Office of Conservation and Solar Applications). Sep 1979. 115p. Dep. NTIS, PC A06/MF A01.

Environmental development plans (EDPs) are prepared by the Department of Energy (DOE) to help fulfill the Department's responsibility for the development of environmentally acceptable energy technologies. The EDP provides a common basis for planning, managing, and reviewing all environmental aspects of the energy programs under DOE's jurisdiction. The EDP is timed to precede key technology program decisions as the technology moves from the exploratory development stage to an engineering development or technology demonstration phase. To ensure that environmental, health, and safety (EH and S) considerations will be addressed adequately in the technology decision making process, the EDP identifies and evaluates EH and S concerns, defines EH and S research and related assessments to examine or resolve the concerns, provides a coordinated schedule with the technology program for required EH and S research and development, and indicates the timing for environmental assessments, environmental impact statements, environmental readiness documents, and safety analysis reports. This EDP provides a substantial updating of the initial EDP for Buildings and Community Systems (BCS) published in March 1978. It contains information on the BCS technology program, environmental concerns and requirements associated with BCS, and environmental program strategy and management. Three appendixes are included on project screening procedures; federal regulations affecting BCS technologies; and a list of government-sponsored environmental research projects for architectural and engineering systems. (LCL)

3180 (DSE—8702-T1) **Project Monitor: Executive Summary; Introduction; and Summary and Recommendations. Final report.** Hammond, P.Y.; Beck, P.; Doctors, S.I. (Pittsburgh Univ., PA (USA). Research Inst. for Energy Policy). 27 Apr 1979. Contract EM-77-C-01-8702. 52p. Dep. NTIS, PC A04/MF A01.

This report contains the following parts of the larger, companion report, DSE—8702-T2: (a) executive summary; (b) introduction; and (c) summary and recommendations.

3181 **Tree age and cavity initiation by red-cockaded woodpeckers.** Jackson, J.A.; Lennartz, M.R.; Hooper, R.G. *J. For.;* 77: No. 2, 102-103(Feb 1979).

The red-cockaded woodpecker, Picoides borealis, is an endangered species that has declined in numbers with loss of nesting habitat. This loss if due partly to the increased prevalence of short rotations in southern pine forests. Data from Mississippi and South Carolina indicate that, for cavity initiation, the species needs living trees averaging approximately 75 years old for loblolly pine (Pinus taeda), and 95 years old for longleaf pine (P. palustris).

SUPPLY, DEMAND, AND FORECASTING

REFER ALSO TO CITATION(S) 2501, 3155, 3187, 3207, 3208, 3280, 3294, 3616

3182 (DOE/EIA—0035/10(79)) **Monthly Energy Review.** (Department of Energy, Washington, DC (USA). Energy Information Administration). Oct 1979. 119p. NTIS, PC A04/MF A01.

Domestic energy production in July 1979 was 5.1 quadrillion Btu, 2.6% lower than in June and 1.7% lower than in July 1978. Supplies were from dry natural gas, crude oil, coal, hydroelectric power, nuclear electric power, natural gas plant liquids, and electricity produced from geothermal power and wood and waste. The US consumed a total of 6.2 quadrillion Btu of energy in July 1979, 3.1% higher than in June and 0.2% lower than in July 1978. Energy imports in July 1979 totaled 1.6 quadrillion Btu and supplied 25.2% of consumed energy in July, that being 2.1% lower than during July 1978. An article featured in this publication is entitled: Three Mile Island: Possible Regulatory Responses and Their Impacts on the Nation's Short-Term Electric Utility Fuel Outlook, was authored by Gene Clark, Mark Gielecki, and Barry Roberts. (MCW)

3183 (DOE/EIA—0173/3(Vol.3)) **Annual report to Congress: 1978. Volume 3: Forecasts.** (Department of Energy, Washington, DC (USA). Energy Information Administration). 1978. 455p. Dep. NTIS, PC A20/MF A01.

Forecasts of energy futures for the short-term, midterm, and long-term periods using various models and forecasting techniques developed and applied within the Office of Applied Analysis of the EIA are presented. The report provides five basic energy supply and demand scenarios, termed projection series. The projection series are specified by changing the assumptions underlying energy supply and demand, and are prepared for the three time periods: the short term (1979 and 1980), and midterm (1985, 1990, and 1995), and the long term (1995 and 2020). Part I includes an introductory chapter about the methodology as well as the chapter on the world energy market. Part II is a self-contained presentation of the domestic projections for all the periods studied and on finance and government regulations. Parts III, IV, and V present the analysis in a way that follows the flow of energy from primary production to ultimate consumption. Part VI presents an assessment of the related impacts, namely those on employment, regional problems, and social and environmental factors.

3184 (DOE/TIC—10190) **Energy source book.** John,D. (Center for Legislative Improvement, Denver, CO (USA)). Aug 1979. Contract EW-78-X-48-0409. 167p. Dep. NTIS, PC A08/MF A01.

Data are compiled on energy sources for the Rocky Mountain Region. The National Energy Act, major Federal energy legislation, and the state energy legislation, 1974-1979, are subjects covered in the first section. Energy consumption and conservation are discussed in the second section with the aid of charts and statistics and subsections entitled: Potential for Energy Conservation in the Mountain-Plain States, Potential Energy Savings from Weatherization, Residential Energy Conservation Programs, and Thermal Efficienty Standards for New Buildings. Under Energy Resources and Development, Section III, the following subjects are covered: Energy Reserves and Production by State: Oil, Gas, Coal, and Uranium; Potential for Energy Production from Renewable and Non-Conventional Sources; Oil Refining Capacity; Pipelines and Movement of Petroleum; Electrical Generation; Water Requirements for Energy Production; and Severance Taxes in the Mountain-Plain States. The last section provides details on information sources and a glossary.

3185 (DOE/TIC—10273) **Perspective on world energy.** Anderson, T.D. (Oak Ridge National Lab., TN (USA)). 25 Sep 1979. Contract W-7405-ENG-26. 25p. Dep. NTIS, PC A02/MF A01.

Oral Presentation to the United Nations Association of the United States, Nashville Chapter.

The technological world of today finds us with a population of over 4 billion with a doubling time of 30 to 40 years. Even with the rapid introduction of effective fertility control, the momentum of population - a phenomenon caused by a population age structure biased toward the young - will carry us to a population of 12 to 16 billion in the 21st century. With fixed land resources, the energy inputs to support the increased population will be several times the present world energy consumption. How does this conclusion square with the notion that we are running out of energy. Are the billions of new people doomed to malnutrition and disease because we cannot provide the energy needed to support them. The answer is no, according to the author; the proved resources of conventional energy resources are substantial and the prospects of adding to these reserves are good. Furthermore, the unconventional resources of oil, gas, and uranium are many times larger than present conventional reserves. And finally, nuclear fission energy alone could support the world for several centuries.

3186 (EPRI-EA—621-SR(Vol.2)) **Demand 77: EPRI annual energy forecasts and consumption model. Volume 2. Documentation of major forecasting assumptions and description of scenarios.** Borges, A.; Boyd, J.W.; Crow, R.T.; Williams, L.J. (Electric Power Research Inst., Palo Alto, CA (USA)). Jul 1979. 41p. Dep. NTIS, PC A03/MF A01.

The report documents the major assumptions concerning economic growth and energy prices used for DEMAND 77 forecasts of national energy consumption to the year 2000. DEMAND 77 used six energy-consumption scenarios based on energy prices, technological change, and public policy. The three basic scenarios were titled baseline, high electricity consumption, and energy conservation. Each of these was explored with and without natural gas supply restrictions. In addition, one scenario was run in which the prices of all forms of energy quintupled by the year 2000. All of the scenarios used a single forecast of industrial output, personal income, prices of factors of production other than energy, and other variables necessary to drive the forecasts from Wharton Economic Forecasting Associates. Technological change not implicitly accounted for in the forecasting model, in the form of solar energy and electric automobiles, was handled by ex post adjustments. Public policy was included in the form of impacts of the complete implementation of the US government's National Energy Plan (1977) on energy prices and nonprice government actions.

3187 (NP—24129) **Decoupling of economic growth and energy consumption.** Neu, A.D. (Kiel Univ. (Germany, F.R.). Inst. fuer Weltwirtschaft). 1978. 95p. (In German). Dep. NTIS (US Sales Only), PC A05/MF A01.

This contribution to energy discussion deals with possibilities and some promising solutions on how to cover the future energy demand without being dependent on an inflexible bond between economic growth and energy consumption. In order to support the statements presented numerous data from the field of energy production and consumption are given.

3188 **Toward an alternative energy path for California: a preliminary action agenda. Staff draft.** Sacramento, CA; California

Energy Commission (Aug 1979). 232p. (NP—24092). California Energy Commission, 1111 Howe Avenue, Sacramento, CA.

The need for energy initiatives, an alternative energy path, energy goals, mobilizing resources and institutions, Governor's and President's energy proposals, and common themes of proposed initiatives are discussed in the introductory chapter. In Part I, New Initiatives for Energy Conservation, the following subjects are covered: transportation, agriculture and water, buildings, appliances, industry, and general strategies. General energy development initiatives, geothermal, cogeneration, biomass, wind, small hydroelectric development, fuel cells, electricity system operations, and Fuel Use Act are subjects covered in Part II, New Initiatives for Energy Development. Part III, New Initiatives to Encourage a Solar California, covers information on state leaderships; state agency services to local government; financial and incentive actions; prototype design development assistance; public information and training program; research, development, and demonstrations; and impact studies. A summary list of actions by organization is given in the appendix. (MCW)

POLICY, LEGISLATION, AND REGULATION

REFER ALSO TO CITATION(S) 2470, 3162, 3171, 3179, 3203, 3286, 3616

3189 (DOE—1210.1) **Citizen participation manual.** (Department of Energy, Washington, DC (USA)). 13 Aug 1979. 55p. Dep. NTIS, PC A04/MF A01.

The Office of Consumer Affairs has the primary responsibility for managing and coordinating the public-participation efforts of the Department of Energy through public meetings, advisory committee participation, and other outreach mechanisms aimed at assuring all citizens an opportunity to participate in the governmental process relating to energy decisions. The Manual outlines the public-participation policy that should be followed by all offices. All offices are directed to observe the guidance in the manual in shaping and conducting public-participation activities, including the public-participation efforts required by DOE Order 2030, Procedures for the Development and Analysis of Regulations, Standards, and Guidelines. Two chapters included are: Determining Public Participation Needs and Public Participation Plan. (MCW)

3190 (UCRL—83469) **WATER-EPM: the incorporation of water into an energy policy model.** Schrot, M.D. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 12 Oct 1979. 30p. (CONF-791043—4). Dep. NTIS, PC A03/MF A01.

From TIMS/ORSA national meeting; Milwaukee, WI, USA (15 Oct 1979).

Significant amounts of water are consumed as energy is transported from resource regions and processed into gasoline, electric power, etc., available for end-use in a demand region. Indeed, particularly in certain regions, water, even more than energy-resource materials such as coal, gas, or uranium, may eventually constitute a prime constraint on the energy available for end-use. Models designed to forecast energy supply and demand generally do not consider water resources explicitly. This paper addresses the feasibility and usefulness of integrating water into a particular model. The Lawrence Livermore Lab. Energy Policy Model (EPM) is a regionalized, dynamic equilibium model that represents the production, processing, and transport of energy from resource extraction to end-use. This paper consists of a simplified look at the workings of the modeling system underlying the EPM, an overview of the EPM itself, a description of the manner of incorporating water into this model to form WATER-EPM, and a brief discussion of the issues that can be investigated using this augmented model.

FOSSIL FUELS

REFER ALSO TO CITATION(S) 2710, 3159, 3313

3191 (DOE/EV—0046(Vol.1)) **Proceedings of the US Department of Energy environmental control symposium. Volume 1. Plenary session and fossil fuels.** (Department of Energy, Washington, DC (USA). Div. of Environmental Control Technology; Argonne National Lab., IL (USA)). Sep 1979. Contract W-31-109-ENG-38. 655p. (CONF-781109—(Vol.1)). Dep. NTIS, PC A99/MF A01.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

Volume one of the proceedings (Plenary Session and Fossil Fuels) contains papers on environmental pollution control which resulted mainly from US DOE's research programs in coal (preparation, desulfurization, gasification, liquefaction, combustion, fluidized-bed combustion, and pollution control methods with respect to SO_2, NO/sub x/, and CO_2 (global effects and feasibility studies); a few papers deal with oil shale operations and the enhanced recovery of petroleum. Papers have been entered individually into EDB and ERA, with 3 also into EAPA; six papers had been entered previously from other sources. (LTN)

COAL

REFER ALSO TO CITATION(S) 2436, 2438, 2456, 2470, 2472, 2473, 2474, 2475, 2476, 2477, 2478, 2479, 2480, 2481, 2482, 2483, 2484, 3161

3192 (DOE/EV—0046(Vol.1), pp 4-6) **Plenary session: speaker.** Willis, E. (Dept. of Energy, Washington, DC). Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

Possible coal technologies are reviewed. With coal, you can either clean it up at the front end, called beneficiation; you can clean it during the process of combustion itself, as in the atmospheric fluidized bed; or you can do it at the back end of the process with scrubber technologies. You can convert the coal into other products. You can convert it into gas, which has a lot of attraction. You are thereby doing two things: not only are you converting it into an environmentally acceptable product, but you are aiso converting it into a transportation medium making use of the large capital investment in our current natural gas pipeline distribution system. So we are concentrating very heavily on coal gasification as a hedge for the future when our natural gas supplies, now so plentiful, are acutely diminished. Coal gasification doesn't come cheap. The best that we say for coal gasification at the moment is something in the $4 to $5+ per mcf range. Coal liquefaction, which we are also concentrating on for the future, is clearly a very expensive technology today too. Coal liquefaction is something of the order of $25 to $30 per barrel. That is clearly at the moment, not an economic proposition. But we are working on these things, so that we are able to get coal as an option for the future in an environmentally acceptable manner, taking out the pollutants and at the same time, ensuring that our transportation sector and the industry which uses the fuels are properly addressed. We have to start right at the very beginning in every technology we undertake to insure that the environmental factors are taken into account. We shall look very, very carefully right from the beginning, not just at the cost and the economics, but what that technology is going to do for the environment. We cannot, and will not, go down roads which lead to a technology that society will not accept.

PETROLEUM

REFER ALSO TO CITATION(S) 2499, 2500, 2501, 2502, 2695

NATURAL GAS

REFER ALSO TO CITATION(S) 2500, 2515, 2524, 2528

OIL SHALES AND TAR SANDS

REFER ALSO TO CITATION(S) 2544

HYDROGEN AND SYNTHETIC FUELS

REFER ALSO TO CITATION(S) 2710, 3285

ELECTRIC POWER

REFER ALSO TO CITATION(S) 2732, 2793, 2954, 3159, 3263

3193 (DOE/EIA—0044(78)) **Statistics of privately owned electric utilities in the United States: 1978. Classes A and B companies. Energy data report.** Roth, K.; Lyles, R.O. (Department of Energy, Washington, DC (USA). Energy Information Administration). Oct 1979. 688p. Dep. NTIS, PC A99/MF A01.

This publication presents the 42nd consecutive year of comprehensive financial and operating information on all the large privately owned electric utility companies operating in the United States. The information has been taken from the annual reports of Classes A and B electric utilities for 1978. The tabulated schedules contained in this report include balance sheets; income and retained earnings statements; statements of changes in financial position; capital stock and long-term debt; electric operating revenues; customers and sales by classes of service; electric operation and maintenance expenses; utility plant; physical quantities; rates of return on electric utility rate base; rates of return on common equity; interest coverage and capitalization ratios; and advertising and sales expense. A section detailing environmental protection facilities and actual expenses incurred is included for the third time in 1978. (MCW)

3194 (DOE/EIA—0172/78) **Statistics of publicly owned electric utilities in the United States: 1978.** Brown, I.; McEwan, P. (Department of Energy, Washington, DC (USA). Energy Information Administration). Oct 1979. 168p. Dep. NTIS, PC A08/MF A01.

Financial and operating information about publicly owned electric utilities is presented. The statistics are compiled from data taken from the annual report filed by the utilities to the Energy Information Administration. The publication also includes the annual reports for 80 Federal projects. Included for the first time in 1978 is the Laurel River Lake Project. This edition includes an index listing of names for each reporting publicly owned utility by state, or states, in which it operates. A summary for all utilities in total may be found at the beginning of each section. These summaries include the balance sheet, and statements for income accounts, electric operating revenues, electric utility plants, electric operation and maintenance expenses, energy accounts, and physical quantities. (MCW)

3195 (HCP/I—5652-01) **Power pool procedures and key issues.** (Booz, Allen and Hamilton, Inc., Bethesda, MD (USA)). Oct 1978. 83p. NTIS, PC A05/MF A01.

This report presents a description and analysis of the operations and key issues impacting electric utility power pools and other forms of integrated power supply systems. Included are discussions of the following: agreements and operating procedures, emergency procedures, long-term planning, key issues, and regional supply entities. It is concluded that: the economic benefits of integrated pool operations are significant; emerging issues may adversely affect these benefits; and joint industry/government initiatives are required to resolve these issues.

3196 (ILLDOE—79/10) **Handbook of sources of electric utility data (with specific reference to Illinois).** Sanghi, A.K.; Baldwin, R.E.; Sim, C. (Illinois Bureau of the Budget, Springfield (USA). Office of Planning). Mar 1979. 80p. NTIS.

The handbook is geared basically toward the needs of planning or research groups attempting to answer policy questions relating to energy and environment. The handbook is divided into four major sections: the first defines the operational and environmental variables upon which most policy-related research depends; the second provides a list of the most important sources of information defined by the variables set forth in the first section; the third provides a detailed outline of the reports electric utilities must file with the Department of Energy/Energy Information Administration (DOE/EIA); and the fourth cross-references the first and second sections by categorizing data sources by time period covered and size of reporting unit. Projections on energy supply and demand variables are often desired by planning groups. The sources of data on projections, where available, are identified in the fourth section.

3197 (PB—292321) **The long-run incremental cost of electric utilities. Volume I. Final report.** (Ernst and Ernst, Washington, DC (USA)). Jul 1978. 118p. NTIS PC A06/MF A01.

A purely neoclassical approach is reported for costing the generation of electricity. A production function (the relationship of inputs to output) is estimated. Taking input prices as given, a long-run total cost equation is derived by minimizing cost subject to the production function and required outputs. The total cost function is then differentiated to arrive at the marginal costs. Since the pattern of production is explicitly incorporated in the production function, the marginal cost at any level of output can be calculated. For transmission and distribution, as well as customer sales and administrtion and general costs, a statistical approach was used. Two other methods for calculating marginal cost which have had widespread use are compared. The neoclassical method uses the definition of the long run and long-run marginal cost and thus determines the cost of meeting an additional increment in load with an optimal (least cost) plant. The empirical estimates of long-run incremental cost for both the Missouri Public Service Company and for the New England Electrical System are reported.

3198 (SAND—78-1927, pp 78-81) **Economics of the interface between SHAC and electric utility systems.** Ambrose, B.J. 1978.

From Analysis for solar heating and cooling; San Diego, CA, USA (27 Jun 1978).

From an economic standpoint, the most appropriate way to undertake a comparative analysis of solar heating and cooling (SHAC) and its more conventional alternatives is to utilize the life-cycle cost approach. This approach compares the total relevant costs of the systems over their useful lives. Costs included in the analysis are acquisition costs (including delivery and installation), operating costs, maintenance costs, taxes, insurance and any salvage value remaining after removal of the system. Comparison of the various system costs is accomplished by discounting all future costs to an equivalent base - usually a present value basis.

3199 (SAND—78-1927, pp 82-84) **Economic dynamics of interfacing solar heating and cooling systems with electric utilities.** Jardine, D.M. (Kaman Sciences Corp., Colorado Springs, CO). 1978.

From Analysis for solar heating and cooling; San Diego, CA, USA (27 Jun 1978).

Life cycle costing is the traditional approach for the economic evaluation of employing solar heating and cooling systems. Life cycle costing includes the definition of owning costs, operating costs, and maintenance costs over the life of the proposed system. This paper deals with the proper interpretation of operating costs insofar as interfacing solar heating and cooling systems with an electric utility is concerned.

3200 **Electricity supply planning when demand is uncertain.** Boyd, R.; Thompson, R. Sacramento, CA; California Energy Commission (1978). 71p. (NP—24132). The Publisher, 111 Howe Ave., Sacramento, CA 95825.

A brief taxonomy of the different kinds of uncertainties that beset electricity supply planners is presented and how these various classes of uncertainty affect the decision about what is the least-cost expansion decision is described. In particular, it is argued that the effects of short-term uncertainties caused by weather or forced outages or planning decisions can be separated from the longer-range uncertainties caused by unavoidable errors in demand forecasting. The problems of incorporating long-run uncertainties into supply planning decisions are discussed; it is argued that the method used in this study, dynamic programming, is the only one that practically allows true-least-cost supply planning and even then places fairly strong constraints on the detail with which the generating system can be modeled. It is shown that, when demand is uncertain, the least-cost supply plan will often include a substantial fraction of short-lead-time base-load plants even though the deterministic bus-bar cost of the base-load electricity that they produce exceeds that of longer-lead-time plants. Finally, appended to the report is a discussion of the basic dynamic programming algorithm, a description of the computer program used to obtain these results, and a short user's guide to the version that is currently implemented at Teale Data Center for use by the commission staff.

ELECTRIC POWER GENERATION

REFER ALSO TO CITATION(S) 2456, 2484

3201 (DSD—114) **Availability of wood for a 50-MW wood-fired power plant in northern Vermont.** Hewett, C.E. (Dartmouth Coll., Hanover, NH (USA). Thayer School of Engineering). Jun 1978. 115p. Dartmouth College, Hanover, NH.

Whether sufficient quantities of wood are physically and institutionally available to fuel a wood-fired power plant in northern Vermont is determined. The forests of northern Vermont are first characterized, then the basis for ascertaining how much wood physically exists in the area is provided. The quantities of wood available are assessed with both traditional and new whole-tree harvesting technologies. Following demonstation that sufficient supplies of wood can be physically obtained from the forest, the geographical, institutional, social, and economic constraints of wood availability are examined. A best possible estimate of the wood actually available at acceptable cost over the projected life of a 50-MW plant is provided. (MCW)

3202 (DSD—116) **Feasibility of operating a 50-MW wood-fired power plant in northern Vermont: wood availabiity and siting potential. Executive summary.** Hewett, C.E.; High, C.J. (Dartmouth Coll., Hanover, NH (USA). Thayer School of Engineering). Jun 1978. 9p. Dartmouth College, Hanover, NH.

The study was undertaken to: (1) ascertain the biological and institutional availability of wood for a 50-MW wood-fired power plant in Vermont, and (2) choose and evaluate a repesentative list of towns potentially suitable as locations for a plant of this description. To determine if the woodlands of northern Vermont could provide enough material to fuel a 50-MW power plant, the quantity of wood in the forest measured in both round-wood and whole-tree terms, the physical and economic accessibility of the forested land, and the willingness of landowners to allow the harvest of low-quality wood on their property were considered. It is mainly concluded that if all the wood on all commercial forest lands could be cut using whole-tree harvesting methods, and if the standing crop of rough and rotten timber were liquidated over the 20-year amortization period, then the region could sustain the removal of 252 million cubic feet of wood fiber annually, in addition to what is already being harvested. In evaluating sites for the plants, 11 towns were evaluated and classified as: good potential (5); moderate potential (3); and provisionally classified (3). It is mainly concluded that there are towns in northern Vermont that are suitable locations for the plant, but in none of the towns is there a market for the cogenerated steam. (MCW)

3203 (ORNL/TM—6816) **Oak Ridge siting analysis: a baseline assessment focusing on the National Energy Plan.** Honea, R.B.; Hillsman, E.L.; Mader, R.F. (Oak Ridge National Lab., TN (USA)).

Oct 1979. Contract W-7405-ENG-26. 104p. Dep. NTIS, PC A06/MF A01.

Comparison of the amounts of electric-generating capacity planned by the nation's utilities for 1985 and 1990, and the amounts implied by the National Energy Plan (NEP) - presented to Congress in April, 1977, and the forecast by the Project Independence Evaluation System - shows numerous discrepancies between these two views of the future. The NEP required replacement or switching of large amounts of generating capacity to coal in the south central and northeastern parts of the nation, cancellation of plans to burn coal in the Rocky Mountain states, and construction of capacity to burn coal in California. Some of these differences reflect policy assumptions of the NEP, but others stem from restrictions that the Department of Energy placed upon the method of analysis pursued by ORNL. Projections of locations for future generating capacity, as required by the NEP, were made at the county level using the Oak Ridge Spatial Analysis Model (ORSAM). ORSAM is a collection of tools that may be used to address energy facility siting questions. The heart of ORSAM is a set of large geographic data bases and procedures for screening candidate sites and computing their suitability of the NEP revealed some shortcomings of ORSAM and suggested several types of improvements.

ELECTRIC POWER TRANSMISSION AND DISTRIBUTION

REFER ALSO TO CITATION(S) 2925, 2955

3204 (BNL—26397) **Automated poolwide economic dispatch of electric generating units and the concept of natural monopoly.** Allentuck, J. (Brookhaven National Lab., Upton, NY (USA)). 1979. Contract EY-76-C-02-0016. 5p. (CONF-791009—7). Dep. NTIS, PC A02/MF A01.

From International conference on energy use management; Los Angeles, CA, USA (22 Oct 1979).

The formation of power pools for the coordination of capacity expansion and system operation is well known. The coordination of day-to-day operation of power systems in the context of economic dispatch is examined. This coordination raises questions that go to the very concept of electric utilities as natural monopolists in the generation, as opposed to the transmission and distribution, of electrical energy. While the principle of economic dispatch has been known to utility managers for at least 45 years and has been practiced nearly as long by individual firms and power pools - only through technological progress in the development of sophisticated communication and computer systems has its full benefits become available on a poolwide basis. Only recently has poolwide completely automated economic dispatch been implemented for the first time in the United States on the New York Power Pool (NYPP) system. The concept of natural monopolist is reviewed, and the basic principles of economic dispatch are outlined. This is followed by a description of the practical operation of automated dispatch on the NYPP system. The discussion is concluded with an examination of the contradiction between poolwide economic dispatch and the concept of individual utilities as natural monopolists.

CONSUMPTION AND UTILIZATION

REFER ALSO TO CITATION(S) 3180, 3182, 3183, 3286, 3299

3205 (COO—4528-T1(Vol.1)) **Preparation and development of land use energy consumption data sets. Volume 1, phase 1. Final report.** (Urban Systems Research and Engineering, Inc., Cambridge, MA (USA); Multisystems, Inc., Cambridge, MA (USA); EDAW, Inc., San Francisco, CA (USA)). 20 Dec 1978. Contract EC-77-C-02-4528. 138p. Dep. NTIS, PC A07/MF A01.

An analysis was made of the potential usefulness of land-use-related data, the availability of relevant information in the literature, and potential approaches for data collection. This volume describes the results of the analysis, while Volume II contains technical backup materials. Chapter 2 discusses the issue of community classification: questions of classification and aggregation have been the most significant technical issues faced on the project, since they strongly affect the accuracy and usefulness of any data that are developed. Chapter 3 is concerned with consistency of accounting, primarily in the measurement of energy use. Transportation patterns, energy-transmission losses, and energy embodied in materials and structure can all be assigned to various land uses in a number of ways, and it is important to perform the assignment in a way that is valuable for the policies being evaluated. Thus, Chapter 3 forms the structure for the dependent variables of the system: the various types and patterns of energy use, while Chapter 2 describes the structure of the independent variables, which are the land-use patterns described, plus other factors such as climate. Chapter 4 takes these two structures and presents computations of energy use for the various patterns of land uses, based on the literature, and Chapter 5 discusses the implications of these analyses for energy planning. This leads directly to Chapter 6, where recommendations are made regarding both data collection and use of existing data. (MCW)

3206 (IKE-K—54-12) **Estimation of power consumption in private households in West Germany and Baden-Wuerttemberg.** Wiesner, K.; Klaiss, H. (Stuttgart Univ. (TH) (Germany, F.R.). Inst. fuer Kernenergetik und Energiesysteme). Apr 1979. 131p. (In German). Dep. NTIS (US Sales Only), PC A07/MF A01.

For calculating the future energy demand it is necessary to analyze the practice of consumption. Within this analysis the demand for electrical energy plays an important part. For a detailed calculation you have to split the electrical energy in industrial and private demands. This paper estimates the electrical energy consumed in private households in the year 2000. This is done by means of the program RSYST III. The estimation of consumption is based on statistical inquiries about the number of appliances in an average household. Under the assumption of saturation, and with respect to new inventions, the number of appliances is extrapolated up to the year 2000. The results will lead to the energy demand.

3207 (WAOENG—79-1) **Washington state energy use profile, 1960-1978.** Hinman, G.; Allen, G.; Culver, C.; Quarles, E.; Robertson, J. (Washington State Univ., Pullman (USA). Environmental Research Center). Jun 1979. 145p. Dep. NTIS, PC A07/MF A01.

The report provides energy suppliers, consumers, and policy makers with the most current energy data and information possible so that energy planning and policy decisions may be made on an informed basis. The first section covers an overview of demographic and economic factors, energy use, energy resources, and prices. Section II covers energy use by fuel type: petroleum, natural gas, and coal. Section III examines electricity use, supply, and prices. Energy use disaggregated by end use and consuming sector is covered in Section IV for the residential, commercial, industrial, agricultural, and transportation sectors. (MCW)

UNCONVENTIONAL SOURCES AND POWER GENERATION

REFER ALSO TO CITATION(S) 3170, 3313

3208 (NP—24030) **We work with energy.** Kraftanlagen, A.G. (Kraftanlagen A.G., Heidelberg (Germany, F.R.)). 1979. 46p. (In German). Dep. NTIS (US Sales Only), PC A03/MF A01.

This brochure deals with current questions in national economics and economic and social policy. To illustrate the completely, the individual departments of the company discuss work in the fields of geothermal heat, solar energy, heat pumps, wind energy, and bioenergy. This is followed by the 1978 company report and annual balance.

SOLAR

REFER ALSO TO CITATION(S) 2714, 2721, 2724, 2725, 2726, 2727, 2728, 2731, 2733, 2780, 2792, 2793, 2800, 2808, 2813, 2814, 2815, 2841, 2843, 2845, 2846, 2848, 2849, 2867

OTHER

REFER ALSO TO CITATION(S) 2786, 3201, 3202

ENERGY CONVERSION

MHD GENERATORS

REFER ALSO TO CITATION(S) 2406

3209 **Engineering aspects of magnetohydrodynamics, 1978.** Kruger, C.H. (ed.). Stanford, CA; Stanford University (1978). vp. (CONF-780307—).

From 17. symposium on engineering aspects of MHD; Stanford, CA, USA (27 Mar 1978).

A collection of 57 papers by various authors is presented. The papers are grouped into 9 sections entitled: MHD coal combustion, open cycle I, slag effects, electrode wall material I, discharge and plasma effects, open cycle II, electrode wall materials II, closed cycle, and components. 51 papers are separately indexed.

3210 **Coal combustor technology development.** (Avco Everett Res Lab, Inc, Mass). pp A.2.1-A.2.8 of Engineering aspects of magnetohydrodynamics, 1978. Stickler, D.B.; Becker, F.E.; Lothrop, J.W.; DeSaro, R.; Ubhayakar, S.K.; Ballantyne, A. Stanford, CA; Stanford Univ. (1978).

From 17. symposium on engineering aspects of MHD; Stanford, CA, USA (27 Mar 1978).

Rate and efficiency of pulverized coal combustion has been measured under conditions appropriate to MHD system operation. Both a regenerative air heater system and vitiation based hot oxidizer source have been used with single element coaxial injection into plug flow tubular combustors. Combustion at a stoichiometry appropriate for channel power extraction requires about 30 ms for optimum thermal efficiency. With a 70% minus 200 mesh coal, this corresponds to about 95-98% fuel utilization, and suggests a system efficiency gain if the coarse fraction of the pulverized coal were reground. Under rich conditions, residence time required for high fuel utilization increases significantly.

3211 Thermionic emission properties of some synthetic coal slags. (Mont State Univ, Bozeman). pp C.7.1-C.7.5 of Engineering aspects of magnetohydrodynamics, 1978. Anderson, J.; Anderson, W.F.; Wilson, M.; Lapeyre, G.J. Stanford, CA; Stanford Univ. (1978).

From 17. symposium on engineering aspects of MHD; Stanford, CA, USA (27 Mar 1978).

Measurements of the thermionic emission into vacuum have been made for three high silica (up to 60% by weight SiO_2) synthetic slags obtained from the National Bureau of Standards. The slags contained respectively 0%, 10% and 30% K_2O by weight and the measuring temperatures were in the range 1400 K to 1800 K. The results indicate that unlike the case for solid materials, potassium incorporated into the slag surface has little or no effect on the work function and that the mechanism for the large emission currents observed in actual channels must be sought in the interaction of the slag surface with the ambient.

DESIGN AND DEVELOPMENT

3212 (FE—2895-1) MHD high performance demonstration experiment interagency agreement No. ET-78-I-01-2895. Quarterly progress report, April 1, 1978-June 30, 1978. (Arnold Engineering Development Center, Arnold Air Force Station, TN (USA)). Jul 1978. Contract ET-78-I-01-2895. 24p. Dep. NTIS, PC A02/MF A01.

During the period between April 1, 1978 and June 30, 1978, the assembly of the magnet and testing of the burner continued. Two review meetings, one on the generator channel and overall project and another on the magnet system alone, were held at AEDC during this period. The installation of the upper coil pancakes and radius fillers was completed and installation of the remaining force containment structure members was started. A total of seven burner firings were performed, four of which had seed addition; the longest was of 26 sec duration. A tentative test plan outline for the magnet and generator channel testing was presented to DOE. The test plan calls for separate magnet testing prior to powered channel testing. In addition, the plan calls for initial performance demonstration at a 4 Tesla (T) field which allows for the achievement of the experimental goals at a reduced risk to the facility prior to testing of the channel and magnet to full design performance. A detailed cooldown analysis for the critical components of the magnet has been performed and presented to the DOE Magnet Review Committee.

3213 U-25b facility for studies in strong magnetohydrodynamic interaction. (Acad of Sci of the USSR, Inst of High Temp, Moscow). pp F.1.1-F.1.12 of Engineering aspects of magnetohydrodynamics, 1978. Kirillian, V.A.; Sheindlin, A.E.; Karpukhin, A.V.; Maksimenko, V.I.; Pashkov, S.A.; Pinkhasik, D.S.; Privalov, N.P.; Semenov, V.D.; Sidorov, V.S.; Sokirko, Yu.D.; Sokolov, Yu.N.; Shelkov, E.M.; Shanklin, R.V.; Liccardi, A.L.; Rudins, G.; Jackson, W.D. Stanford, CA; Stanford Univ. (1978).

From 17. symposium on engineering aspects of MHD; Stanford, CA, USA (27 Mar 1978).

This paper describes the general layout and the main components of the U-25B facility, which is located in Moscow, U.S.S.R. Its use of a superconducting magnet built for the U.S. Department of Energy by the Argonne National Laboratory and its relatively large scale will allow the investigation of component performance under those conditions of strong electromagnetic interaction and high thermal and structural stresses which are envisaged for commercial MHD plants.

3214 Development of a compact, lightweight high performance 30 MW MHD generator system. (Maxwell Lab, Inc, Woburn, Mass). pp F.5.1-F.5.10 of Engineering aspects of magnetohydrodynamics, 1978. Sonju, O.K.; Swallom, D.W.; Meader, D.E.; Becker, H.; Burry, R.V.; Huebner, A.W.; Cooper, R.F. Stanford, CA; Stanford Univ. (1978).

From 17. symposium on engineering aspects of MHD; Stanford, CA, USA (27 Mar 1978).

This paper describes the current phase of a multi-phase program to design, construct, and test a lightweight, high power prototype transportable MHD generator system. The main purpose of this phase is to demonstrate the feasibility of the hot gas flow train components of high performance, lightweight design. In the present program significant advances in terms of such parameters as combustor heat release density, combustion efficiency, channel power density and energy extraction rates are made. The combustion system has a high performance, 160 element injector and the channel was constructed using lightweight electrode frames and a high strength, lightweight glass-fiber wound composite outer wall structure. The results of this phase of the development program that are reported in this paper are part of an overall advancement of the state-of-the-art of compact, lightweight high performance MHD channels and diffusers for transportable burst power MHD generator systems.

3215 Dynamics of a free-piston diesel MHD generator. (Acad of Sci of the USSR, Inst of High Temp, Moscow). pp H.8.1-H.8.7 of Engineering aspects of magnetohydrodynamics, 1978. Bashkatov, V.A.; Kirillov, Yu.M.; Safonova, S.S.; Shelkov, E.M.; Shpilrain, E.E. Stanford, CA; Stanford Univ. (1978).

From 17. symposium on engineering aspects of MHD; Stanford, CA, USA (27 Mar 1978).

Direct heat to electricity conversion was theoretically studied for an auto-oscillating process in a free-piston system. The free-piston system consisted of a diesel drive and two conductive liquid metal MHD-generators. The method of calculation of dynamic characteristics of the system was worked out. This method is based on a boundary-value problem for an equation of the moving parts mass center motion. In this equation friction in various parts of the system were taken into consideration. The calculations carried out show that the efficiency value for a free-piston diesel- MHD-generator can reach 34 + 36%. The results of the calculations of the free-piston diesel-MHD-generator transition modes at sharp changes of load values are presented.

3216 Transient response of MHD/steam bottoming plants with phased air preheaters and heat capacitor. (Mont State Univ, Bozeman). pp I.4.1-I.4.6 of Engineering aspects of magnetohydrodynamics, 1978. Johnson, R.; Robles, T. Stanford, CA; Stanford Univ. (1978).

From 17. symposium on engineering aspects of MHD; Stanford, CA, USA (27 Mar 1978).

A detailed dynamic model of the steam bottoming portion of an MHD/ steam plant which has been programmed is briefly described. The program is suitable for investigation of a variety of transients effecting the bottoming portion of combined MHD/steam plants including the response of electrical and thermal changes on air preheater cycling temperatures and seed condenser performance. After a brief discussion of the model, results are presented for two case studies which are typical of those expected as a consequence of MHD topping cycle fault or rapid load change in a 250 MWT ETF power plant.

PERFORMANCE AND TESTING

REFER ALSO TO CITATION(S) 3212, 3229, 3245, 3247

3217 (DOE/EV—0046(Vol.1), pp 571-593) Control of nitrogen oxide emissions in coal-fired, open-cycle MHD power plants. Epstein, J. (Dept. of Energy, Washington, DC). Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

The control of nitrogen oxide (NO/sub x/) emissions from coal-fired power plants, including Magnetohydrodynamic (MHD) systems is an issue which most often appears in the evaluation of a new technology. Since the 1960's, the MHD community has given considerable attention to NO/sub x/ control and has directed significant effort in research, analysis and experimental activities focused at reducing NO/sub x/ emissions to presently-proposed standards and to values which may become the standards in the period of commercialization. Present information indicates that both current and future NO/sub x/ standards can be met by the MHD process even though no credit is provided for the significant increase in net plant efficiency over conventional power plant systems. Presently available results from experiments as high as 8 MWt and from calculations based on experimentally derived kinetics data have served to empirically identify realistic NO/sub x/ control techniques. The preferred system operation is to: (a) operate the coal combustor fuel rich, (b) cool the gas slowly in a radiant boiler downstream of the MHD channel/diffuser, (the radiant boiler is the key component in MHD NO/sub x/ control), and (c) add additional air to the radiant-boiler exhaust, at a temperature high enough to complete combustion but low enough to minimize the tendency to form additional NO/sub x/. These concepts are discussed in detail along with experimental and analytical results that have been obtained to verify that the method of control is technically sound and practical. Current DOE-sponsored R and D efforts are aimed at optimizing the method and at formal demonstration in suitable facilities.

3218 Open-cycle disk generator studies. (Avco Everett Res Lab, Inc, Mass). pp B.1.1-B.1.5 of Engineering aspects of

magnetohydrodynamics, 1978. Klepeis, J.E. Stanford, CA; Stanford Univ. (1978).

From 17. symposium on engineering aspects of MHD; Stanford, CA, USA (27 Mar 1978).

In the first part of the paper a theoretical correlation is presented to explain the enthalpy extraction performance of two radial-flow, open-cycle disk channels: Disk-1 and Disk-2. The channels were driven by a large shock tube, and were operated at flow conditions that simulated coal-firing at high air preheat. Magnetic fields up to 4.5 tesla were applied. Disk-2 performed twice as well as Disk-1 and achieved an enthalpy extraction of 15% at an estimated isentropic efficiency of ≧ 55%. In the second part of the paper, application of the disk concept to commercial, open-cycle, coal-fired MHD power generation is discussed.

3219 Detailed characterization of MHD generator operating parameters. (Avco Everett Res Lab, Inc, Mass). pp F.4.1-F.4.8 of Engineering aspects of magnetohydrodynamics, 1978. Kessler, R.; Solbes, A. Stanford, CA; Stanford Univ. (1978).

From 17. symposium on engineering aspects of MHD; Stanford, CA, USA (27 Mar 1978).

Experiments were conducted to investigate detailed operating characteristics of combustion-driven slagging MHD generators. Performance characteristics of two different generators are compared. One generator was built with conventional flat electrode walls and the other had V-shaped electrode walls. Both generators had peg-type insulator walls which were used for detailed electrical diagnostics.

3220 Performance of a closed cycle MHD generator with molecular impurities. (Eindhoven Univ of Technol, Neth). pp H.2.1-H.2.6 of Engineering aspects of magnetohydrodynamics, 1978. Zlatanovic, M.; Veefkind, A.; Rietjens, L.H.Th. Stanford, CA; Stanford Univ. (1978).

From 17. symposium on engineering aspects of MHD; Stanford, CA, USA (27 Mar 1978).

The influence of small amounts of molecular impurities on the properties of a noble gas alkali MHD plasma has been investigated theoretically and experimentally. The influence of nitrogen and carbon dioxide on an argon-cesium working fluid is considered. Experimental investigations consisting of the addition of well defined amounts of N_2 and CO_2 to the MHD generator plasma, are carried out in the Eindhoven shock tunnel experiment. The theoretical analysis is restricted to N_2.

3221 Noble gas MHD generator experiments at low stagnation temperatures. (Eindhoven Univ of Technol, Neth). pp H.3.1-H.3.7 of Engineering aspects of magnetohydrodynamics, 1978. Veefkind, A.; Hellebrekers, W.M.; Borghi, C.A.; Rietjens, L.H.Th. Stanford, CA; Stanford Univ. (1978).

From 17. symposium on engineering aspects of MHD; Stanford, CA, USA (27 Mar 1978).

The performance of a noble gas MHD generator at stagnation temperatures of 2000 K and lower has been investigated experimentally in the MHD shock tunnel facility. The electrical power becomes equal to zero at stagnation temperatures around 1700 K. The decrease of the power is accompained by a strong increase in the inlet relaxation length. The results, including the minimum stagnation temperature of 1700 K, are strongly dependent on the magnetic induction. The purpose of this part of the work is to provide in a more extensive set of experimental data on discharge structures at different magnetic inductions and different stagnation temperatures.

3222 Design of the Eindhoven 5 MW thermal MHD blow down experiment. (Eindhoven Univ of Technol, Neth). pp H.4.1-H.4.6 of Engineering aspects of magnetohydrodynamics, 1978. Blom, J.H.; Balemans, W.J.M.; Flinsenberg, H.J.; Kleijn, D.J.; Massee, P.; Merck, W.F.H.; Rietjens, L.H.Th. Stanford, CA; Stanford Univ. (1978).

From 17. symposium on engineering aspects of MHD; Stanford, CA, USA (27 Mar 1978).

A 5 MW closed cycle MHD blow down experiment has been designed. The facility is rated to deliver an argon mass flow of 5 kg/s with a temperature of 2000 K and a pressure of 7 bar. A cesium aerosol is injected upstream of the generator to provide a maximum seed ratio of 0.1%. The total flow time is one minute. A cryogenic magnet provides a magnetic field of 5 T during 11 s. The argon gas is heated with a clean gas fired regenerative heat exchanger. The generator channel will operate in a heat sink mode and is designed for 20% enthalpy extraction.

3223 Power generation experiments of a linear MHD generator with fully ionized seed. (Tokyo Inst of Technol, Meguro, Jpn). pp H.5.1-H.5.5 of Engineering aspects of magnetohydrodynamics, 1978. Shioda, S.; Yamasaki, H.; Masuhara, Y. Stanford, CA; Stanford Univ. (1978).

From 17. symposium on engineering aspects of MHD; Stanford, CA, USA (27 Mar 1978).

Power generation experiments for a linear Faraday generator with small seed fractions of 10^{-5}-10^{-4} have been conducted in order to show the recovery of δ/sub eff/ and power density due to the suppression of ionization instability and to demonstrate the possible operation of a linear generator with fully ionized seed. The results indicate the possible operation of a linear generator with fully ionized seed and the increase of isentropic efficiency of a closed cycle inert gas MHD generator can be expected.

MATERIALS, COMPONENTS, AND AUXILIARIES

REFER ALSO TO CITATION(S) 3212, 3486

3224 (AD-A—063386) **Research on non-ideal plasmas. Final report 25 May 1977-24 May 1978.** Baum, D.W.; Gill, S.P.; Shimmin, W.L.; Mukherjee, D. (Artec Associates, Inc., Hayward, CA (USA)). 24 Jul 1978. Contract N00014-77-C-0463. 121p. NTIS PC A06/MF A01.

Research on advanced high performance explosive plasma sources for pulsed MHD power generators is reported.

3225 Mechanistic modeling of pulverized coal combustion. (Avco Everett Res Lab, Inc, Mass). pp A.1.1-A.1.7 of Engineering aspects of magnetohydrodynamics, 1978. Stickler, D.B.; Ubhayakar, S.K. Stanford, CA; Stanford Univ. (1978).

From 17. symposium on engineering aspects of MHD; Stanford, CA, USA (27 Mar 1978).

This paper addresses an analytical model developed to simulate an MHD coal combustor. The model highlights the various physicochemical mechanisms which are of importance in a high temperature pulverized coal combustor using a hot oxidizing gas. The purpose of the model is to minimize exploratory experimental study, and give a basis for the use of basic combustion information in combustor design, without depending exclusively on empirical hardware testing. The model breaks down into three major conceptual blocks: fluid dynamics, particle processes and gas chemistry. Each of these blocks, as well as the coupling between them are discussed.

3226 Sensitivities of outputs to variations of inputs in MHD combustors. (Mont State Univ, Bozeman). pp A.3.1-A.3.6 of Engineering aspects of magnetohydrodynamics, 1978. Rudberg, D.A.; Dudding, C.H. Stanford, CA; Stanford Univ. (1978).

From 17. symposium on engineering aspects of MHD; Stanford, CA, USA (27 Mar 1978).

As a first step in control policy synthesis, identification of input-output characteristics of system components is necessary. This paper graphically presents sensitivities of outputs to variations of inputs in MHD combustors. Results are given for combustors having 45 MW/sub t/ and 356 MW/sub t/ total input. Output temperature, char burnout, electrical conductivity, and heat loss are shown as functions of a wide variety of input variations.

3227 Cyclone and fluidized bed combustion concepts for coal fired open cycle MHD. (GE, Philadelphia, Pa). pp A.6.1-A.6.8 of Engineering aspects of magnetohydrodynamics, 1978. Omori, S.; Hnat, J.; Bazan, J.; Biswas, B. Stanford, CA; Stanford Univ. (1978).

From 17. symposium on engineering aspects of MHD; Stanford, CA, USA (27 Mar 1978).

Predicted performances of fluidized bed and cyclone combustion schemes were compared as part of a recent conceptual design study of a subscale (250 MWt), open-cycle MHD Engineering Test Facility. Both combustion concepts were two-stage gasification/combustion systems designed for high slag/ash rejection with predictions for slag/ash rejection being greater than 99% and 90% for the fluidized bed and cyclone concepts respectively. For the particular two-stage combustion systems evaluated, analyses indicated that for the same thermal input, maximum air preheat temperature, and exit pressure, the cyclone combustion scheme had slightly better thermodynamic performance than the fluidized bed scheme.

3228 Electrode development for coal fired MHD generators. (Avco Everett Res Lab, Inc, Mass). pp D.1.1-D.1.6 of Engineering aspects of magnetohydrodynamics, 1978. Demirjian, A.; Petty, S.W.; Solbes, A. Stanford, CA; Stanford Univ. (1978).

From 17. symposium on engineering aspects of MHD; Stanford, CA, USA (27 Mar 1978).

The paper focuses on two key aspects of the electrode wall behavior in slagging linear MHD channels. The first problem is related to electrode life-time and anodes in particular. The electrode design principle is based on the utilization of massive water cooled copper current lead outs, capped with oxidation resistant materials to minimize anodic erosion. The results of numerous cap material tests, conducted in the Mark VI facility, are discussed in detail. The second aspect characteristic of the operation of slagging channel is the development of cathode wall non-uniformities. It is shown that these are related to slag layer leakage and the salient features of the phenomenon are analyzed in detail.

3229 Insulator performance and anode recession rate in a direct coal fired cold copper diagonal conducting wall MHD generator. (Univ of Tenn Space Inst, Tullahoma). pp D.2.1-D.2.6 of Engineering aspects of magnetohydrodynamics, 1978. Beaton, M.S.; Scott, M.H.; Wu, Y.C.L.; Dicks, J.B. Jr.; Muehlhauser, J.W.; Holt, W.L.; James, H.D. Stanford, CA; Stanford Univ. (1978).

From 17. symposium on engineering aspects of MHD; Stanford, CA, USA (27 Mar 1978).

This paper reports the results of a series of tests conducted at the University of Tennessee Space Institute in its water-cooled copper, diagonal conducting wall MHD generator. These tests were conducted (1) to evaluate a number of combinations of commercially available dielectric sheet materials and arc plasma sprayed ceramic coatings as interelectrode insulation systems; (2) to correlate anode loss with total current for each electrode; and (3) to study generator performance and its relationship with the material stability. Results are discussed.

3230 Electrochemical corrosion of MHD electrodes in slags. (Westinghouse Electr Corp, Res and Dev Cent, Pittsburgh, Pa). pp D.4.1-D.4.12 of Engineering aspects of magnetohydrodynamics, 1978. Cadoff, L.H.; Rossing, B.R.; Smith, H.D. Stanford, CA; Stanford Univ. (1978).

From 17. symposium on engineering aspects of MHD; Stanford, CA, USA (27 Mar 1978).

In this work, electrochemical screening tests have been conducted at various temperatures and current densities on a variety of candidate electrode materials (i.e., $MgCr_2O_4$, Pt, Fe, $3MgAl_2O_4$: $1Fe_3O_4$, $MoSi_2$, $LaCrO_3$) in an eastern USA coal slag. Several types of test cells designed to simulate electrochemical reactions in "virgin" slag and in slag that becomes saturated with electrode/slag reaction products are described. The chemistry, mechanisms and kinetics of electrode/slag reactions have been evaluated and is discussed in detail. The implications of these results on selecting electrode materials and in selecting conditions for operating an MHD channel under slagging conditions are discussed.

3231 Thermal properties of MHD electrode materials. (Battelle, Pac Northwest Lab, Richland, Wash). pp D.6.1-D.6.7 of Engineering aspects of magnetohydrodynamics, 1978. Bates, J.L.; Merchant, D.D. Stanford, CA; Stanford Univ. (1978).

From 17. symposium on engineering aspects of MHD; Stanford, CA, USA (27 Mar 1978).

The thermal conductivity and thermal expansion of a number of oxide electrodes and insulators of interest to MHD have been measured from 400 to 1850°K. The results are summarized and discussed in terms of fabrication, microstructure, and phase changes. Arc plasma sprayed, sintered, and hot pressed materials are discussed. Equations for the thermal conductivity and the thermal expansion coefficients as functions of temperature are given where possible.

3232 Design and operation of the Westinghouse Electrode Systems Test Facility (WESTF). (Westinghouse Res and Dev Cent, Pittsburgh, Pa). pp G.1.1-G.1.8 of Engineering aspects of magnetohydrodynamics, 1978. Dilmore, J.A.; Lempert, J.; Schneider, S.J.; Frantti, E.W. Stanford, CA; Stanford Univ. (1978).

From 17. symposium on engineering aspects of MHD; Stanford, CA, USA (27 Mar 1978).

This paper describes a 1.0 MW (thermal) test facility designed to provide a wide range of MHD generator conditions (MHD stresses) to evaluate the promise of MHD electrode systems. An electrode system is defined as the basic generator elements which allow for current transfer, electrical insulation and thermal management. Electrode systems contain strong components of design and materials development. This paper does not only describe the design and operation of this facility but also the techniques used to evaluate the electrical and thermal performance of electrode systems.

3233 Design, test and evaluation of refractory MHD electrodes. (Westinghouse Electr Corp, Pittsburgh, Pa). pp G.3.1-G.3.9 of Engineering aspects of magnetohydrodynamics, 1978. Sadler, J.W.; Calvo, R.; Driesen, G.E.; Eggers, A.; Kochka, E.L.; Rossing, B.R. Stanford, CA; Stanford Univ. (1978).

From 17. symposium on engineering aspects of MHD; Stanford, CA, USA (27 Mar 1978).

In this paper the engineering approach used in the design, test and evaluation of refractory MHD electrodes considered for inclusion in the U-02 Phase III Electrode Walls is discussed. Notwithstanding the crucial importance of materials and detailed materials based interactions in the design and evaluation of electrode systems, this paper addresses the engineering application of previously "qualified" materials. Materials characteristics are discussed only to the extent that they impacted the thermal or structure design of the electrode system. Experience summarized herein affirms the value of coordinated engineering design, test and post test evaluation techniques which are necessary in the development of refractory electrode/insulator systems for application in MHD generators.

3234 Properties and test results of super-hot wall electrode materials. (MIT, Cambridge, Mass). pp G.5.1-G.5.6 of Engineering aspects of magnetohydrodynamics, 1978. Cannon, W.R.; Yoshimura, M.; Mizusaki, J.; Sasamoto, J.; Pober, R.L.; Hart, J.; Bowen, H.K.; Louis, J.F. Stanford, CA; Stanford Univ. (1978).

From 17. symposium on engineering aspects of MHD; Stanford, CA, USA (27 Mar 1978).

Studies in the laboratory and in an MHD channel simulator have been made to relate the chemical stability to the performance. New materials have been investigated for use as hot electrodes (T > 1700°C) from the ternary $LaFeO_3$-$SrZrO_3$-SrFeO/sub 3-x/ and from the binary system $La_{0.75}Sr_{0.25}(Fe_{0.05}Cr_{0.25})$ O_3 - $SrZrO_3$. Phase diagrams are presented, as well as, electronic conductivity and phase stability data for several compositions. A quantitative formula has been developed to determine chemical potential of the elements in the electrode or slag and is based on physical properties data and operating conditions. This expression allows for the prediction of the stability of the materials due to electrochemical effects.

3235 Development of a potential electrode material for MHD: yttrium orthoferrite. (Trans-Tech, Inc, Gaithersburg, Md). pp G.6.1-G.6.5 of Engineering aspects of magnetohydrodynamics, 1978. Domingues, L.P.; Negas, T.; Armstrong, A.J.; Hosler, W.R. Stanford, CA; Stanford Univ. (1978).

From 17. symposium on engineering aspects of MHD; Stanford, CA, USA (27 Mar 1978).

Yttria-based ceramics have not been developed fully for MHD applications. As part of an expanded program, this paper presents some exploratory data related to $YFeO_3$-type materials. Preparation and microchemical/microstructural details together with relevant electrical conductivity and thermal expansion data are given. Emphasis is on $YFeO_3$-$CaFeO_{2.5}$-$CaZrO_3$ solid solutions and composites.

3236 Consolidation and local control of power in an MHD generator. (Avco Everett Res Lab, Inc, Mass). pp I.1.1-I.1.6 of Engineering aspects of magnetohydrodynamics, 1978. Lowenstein, A. Stanford, CA; Stanford Univ. (1978).

From 17. symposium on engineering aspects of MHD; Stanford, CA, USA (27 Mar 1978).

The operating characteristics of two circuits for the consolidation and control of power out of the MHD generator have been studied both analytically and experimentally in tests on the Avco Mark VI. The first circuit utilizes the principle of inductive coupling of electrode currents. The second circuit uses a novel scheme whereby a capacitor provides the required isolation between two electrodes, while power from the two electrodes is delivered to a common point. Two methods of forming cascaded networks for handling a multiple of electrodes using either of these two consolidation elements are also described.

3237 Developments in electrodes and power conditioning systems for open-cycle MHD generators. (GE, King of Prussia, Pa). pp I.2.1-I.2.8 of Engineering aspects of magnetohydrodynamics, 1978. Zauderer, B.; Coppa, A.P.; Noone, M.J.; DeDominicis, L.; Gatti, A.; Rogers, D.A.; Feingold, E.; Faust, B. Stanford, CA; Stanford Univ. (1978).

From 17. symposium on engineering aspects of MHD; Stanford, CA, USA (27 Mar 1978).

Recent and continuing developments in electrodes, electric control, and inversion systems for open-cycle MHD generators at the General Electric Company Space Sciences Laboratory are described. Materials and design considerations are discussed, with an emphasis given to the flexible support of ceramic electrodes. A rationale for selecting the appropriate level of flexibility is briefly described. Test results obtained from actual and simulated MHD tests of these electrodes and post-test materials characterization data are presented. These results demonstrate the effectiveness of unique electrode design features introduced in the program.

3238 Inverter development at UTSI. (Univ of Tenn Space Inst, Tullahoma). pp I.3.1-I.3.6 of Engineering aspects of magnetohydrodynamics, 1978. Petersen, C.K.; Barnett, L.; Stephenson, L.; Scott, M.H. Stanford, CA; Stanford Univ. (1978).

From 17. symposium on engineering aspects of MHD; Stanford, CA, USA (27 Mar 1978).

A four unit MHD channel inverter system using line or McMurray commutation has been built and partially tested at UTSI. Testing has included using either a dc power supply or power from the MHD channel. It was found that a multiple inverter loading units system increases the performance of the UTSI channel by as much as 7 percent for an eight unit loading system. It was also found that substantial electrical filtering of the MHD power must be used to eliminate noise on the MHD power. The noise on the MHD power was found to increase the probability of commutation failure. McMurray commutation was found more susceptible to noise induced commutation failure than line commutation.

DUCT ENGINEERING AND FLUID DYNAMICS

REFER ALSO TO CITATION(S) 3228

3239 (ARI-RP—38) **Characterization of open-cycle, coal-fired MHD generators. Seventh-eighth quarterly technical progress report, January 1-June 30, 1978.** Kolb, C.E.; Elgin, J.B.; Wormhoudt, J.; Yousefian, V.; Martinez-Sanchez, M.; Dvore, D. (Aerodyne Research, Inc., Bedford, MA (USA)). Jul 1978. Contract EX-76-C-01-2478. 33p. Dep. NTIS, PC A03/MF A01.

The successful design of full-scale open-cycle, coal-fired MHD generators for baseload electrical production requires a detailed understanding of the plasma chemical and plasma dynamic characteristics of anticipated combustor and channel fluids. This report documents progress in efforts to model negative ion formation and slag condensation effects on core flow conductivity, to improve the ability to sample and characterize laboratory produced coal combustion plasmas, and to define a mathematical model of the diffuse discharge plasma sheath in the anode boundary layer.

3240 **Two-dimensional effects in disk MHD generators.** (MIT, Cambridge, Mass). pp B.2.1-B.2.7 of Engineering aspects of magnetohydrodynamics, 1978. Dvore, D.S.; Martinez-Sanchez, M.; Shama, S.E. Stanford, CA; Stanford Univ. (1978).

From 17. symposium on engineering aspects of MHD; Stanford, CA, USA (27 Mar 1978).

This paper presents results of a numerical study of the effects and dynamics of wakes in disk generators with swirl. In the first part of the work the flow is considered unaffected by the MHD effects (small interaction limit) and the purely electrodynamic effects of the wakes are studied. In the second part a significant interaction level is introduced, and some results are given that show the dynamics of inviscid wakes; the work in this respect is in progess.

3241 **Finite element approach to three-dimensional current distributions in diagonal wall channels.** (Kyoto Univ, Jpn). pp B.5.1-B.5.7 of Engineering aspects of magnetohydrodynamics, 1978. Hara, T.; Umoto, J. Stanford, CA; Stanford Univ. (1978).

From 17. symposium on engineering aspects of MHD; Stanford, CA, USA (27 Mar 1978).

The first purpose of this paper is to apply the finite element method (FEM) to a numerical calculation of three-dimensional potential and current distributions in diagonal MHD generator channels. For this problem, the FEM has advantages over the finite difference method. The second purpose of the paper is to make clear the necessity of the three-dimensional analysis by comparing the current distributions obtained by two-dimensional calculations with the ones by three-dimensional calculations, and then to make a detailed comparison between the characteristics of the insulating and the conducting sidewall channels by means of the three-dimensional analysis. The third purpose of the paper is to investigate the performance characteristics of the generator with the circular cross section by means of three-dimensional calculations, and to compare the characteristics with those of the generator with the rectangular cross section.

3242 **Compositional modeling of MHD channel slag, with preliminary vapor pressure data.** (NBS, Washington, DC). pp C.1.1-C.1.6 of Engineering aspects of magnetohydrodynamics, 1978. Plante, E.R.; Cook, L.P. Stanford, CA; Stanford Univ. (1978).

From 17. symposium on engineering aspects of MHD; Stanford, CA, USA (27 Mar 1978).

Bulk compositional models for MHD channel slags are proposed on the basis of a statistical treatment of coal ash analyses and a consideration of available channel slag data. These model compositions reflect the relatively high CaO content of sub-bituminous ("Western") coal ash, the relatively high FeO/sub x/ content of bituminous ("Eastern") coal ash, and the relative depletion of $SiO_2/(SiO_2 + Al_2O_3)$ in the channel. Selective partitioning of iron, calcium and magnesium into the liquid phase with falling temperature is predicted. Vapor pressure measurements on the model Western channel slag were carried out during which the bulk composition of K_2O decreased from 22.7 to 7 wt %.

3243 **Fluid mechanics and thermal behavior of MHD channel slag layers.** (Stanford Univ, Calif). pp C.2.1-C.2.6 of Engineering aspects of magnetohydrodynamics, 1978. Rodgers, M.E.; Kruger, C.H. Stanford, CA; Stanford Univ. (1978).

From 17. symposium on engineering aspects of MHD; Stanford, CA, USA (27 Mar 1978).

Duct wall slag films are investigated experimentally for two coal types and several operating conditions. Surface temperature, layer thickness, and slag layer run-off are measured. The effect of substrate temperature, ash feed-rate, potassium, and plasma velocity are studied. Run-off data are consistent with deposition models. With slag properties inferred from available published data, measured and calculated thickness and surface temperature are in general agreement.

3244 **Discharge characteristics of slagging metal electrodes.** (Stanford Univ, Calif). pp C.3.1-C.3.9 of Engineering aspects of magnetohydrodynamics, 1978. Koester, J.K.; Nelson, R.M. Stanford, CA; Stanford Univ. (1978).

From 17. symposium on engineering aspects of MHD; Stanford, CA, USA (27 Mar 1978).

The behavior of slag coated electrodes under applied transverse discharges at MHD generator duct conditions was investigated for both arc mode and diffuse mode operation. Slag layers were found to have substantial ionic conductivity with iron and potassium as the mobile species. Severe anodic polarization was observed for all materials other than low carbon steel. The "plating out" of iron in the slag layer was observed at the cathode wall. The arc discharge through slag was studied for several electrode materials including platinum clad copper. Arc voltage drop, size, distribution, and surface temperature were determined. In situ slag layer resistance was measured as a function of current and spurious low values of axial resistance were observed at the cathode wall.

3245 **Computer modeling of the effects of coal ash chemistry on the performance of MHD generators.** (Aerodyne Res, Inc, Bedford, Mass). pp C.4.1-C.4.6 of Engineering aspects of magnetohydrodynamics, 1978. Yousefian, V.; Wormhoudt, J.; Kolb, C.E.; Martinez-Sanchez, M.; Kerrebrock, J.L. Stanford, CA; Stanford Univ. (1978).

From 17. symposium on engineering aspects of MHD; Stanford, CA, USA (27 Mar 1978).

A computer program code, the PACKAGE (Plasma Analysis, Chemical Kinetics And Generator Efficiency) has been developed to perform calculations of coal combustion plasma compositions and the effects of these compositions on plasma conductivity and generator efficiency. This report contains PACKAGE code calculations for typical full-scale generator conditions on the effects of liquid solution versus pure condensed phase modeling on the vapor phase concentration of neutral and ionic metal oxide species and the effects of finite rate kinetics on the concentrations of vapor phase metal oxide species. Finally, the negative ion species sampled from a laboratory plasma produced by methane augmented combustion of Montana Rosebud coal with preheated air and potassium carbonate seed are compared with PACKAGE code predictions.

3246 **MHD slag electrical conductivity studies.** (Mont State Univ, Bozeman). pp C.6.1-C.6.6 of Engineering aspects of magnetohydrodynamics, 1978. Pollina, R.; Larsen, R. Stanford, CA; Stanford Univ. (1978).

From 17. symposium on engineering aspects of MHD; Stanford, CA, USA (27 Mar 1978).

Aim of this article is to provide electrical conductivity data for coal slag in a form that can be utilized by designers in modeling the output of the channel and by operators in anticipating the conductivity behavior of slag in any thermal and chemical environment which might occur when larger scale projects become operational. Authors show that over a limited temperature range, the slag electrical conductivity of Rosebud coal can be described by a closed-form mathematical expression to an accuracy of about ten percent as a function of temperature and iron content.

3247 **Axial interelectrode breakdown in MHD channels.** (Acad of Sci of the USSR, Inst of High Temp, Moscow). pp E.1.1-E.1.7 of Engineering aspects of magnetohydrodynamics, 1978. Baranov, N.N.; Burenkov, D.K.; Dolinski, Yu.L.; Izerov, A.D.; Kirillov, V.V.; Klimovski, I.I.; Kovbasiuk, V.I.; Shumiatski, B.Ya.; Tihotski, A.S.; Uspenskaia, G.L.; Zalkind, V.I. Stanford, CA; Stanford Univ. (1978).

From 17. symposium on engineering aspects of MHD; Stanford, CA, USA (27 Mar 1978).

The results of stage II experimental study of interelectrode breakdown in the U-02 facility and investigation of interelectrode arcing in the MHD channels of the U-25 Power Plant are summarized. The dependences of the voltages of the Hall breakdown and arcing between the adjacent electrodes (both cathodes and anodes) upon the Faraday current and the width of interelectrode insulator, obtained at various parameters of MHD generator, are presented. A possible explanation of the breakdown phenomena is discussed.

3248 **Current distribution in channels with elliptic cross section and nonuniform velocity and conductivity.** (MIT, Cambridge, Mass). pp E.4.1-E.4.7 of Engineering aspects of magnetohydrodynamics, 1978. Shamma, S.E.; Martinez-Sanchez, M.; Louis, J.F. Stanford, CA; Stanford Univ. (1978).

From 17. symposium on engineering aspects of MHD; Stanford, CA, USA (27 Mar 1978).

In this paper, exact solutions of the electric potential distributions are given for cylindrical channels with elliptical cross sections, with arbitrary aspect ratio, and with nonuniform velocity and conductivity of boundary layer type. The dependence of the electric field, and current, and also of the integral characteristics of the channels, on the inhomogeneity parameters are presented analytically, and detailed solutions are given graphically for a range of frame

angles, channel aspects ratios and type and strength of boundary layers.

3249 Diagonal frame RM channel of the U-25 power plant. (Acad of Sci of the USSR, Inst of High Temp, Moscow). pp F.2.1-F.2.9 of Engineering aspects of magnetohydrodynamics, 1978. Barshak, A.E.; Bityurin, V.A.; Buznikov, A.E.; Karpukhin, A.V.; Kovbasiuk, V.I.; Maksimenko, V.I.; Medin, S.A.; Pishchikov, S.I. Stanford, CA; Stanford Univ. (1978).

From 17. symposium on engineering aspects of MHD; Stanford, CA, USA (27 Mar 1978).

In the paper a brief description of design and main results of the tests of the diagonal frame RM channel are given. At the U-25 power plant long duration tests of the RM channel were performed including continuous duration run of 250 hours at maximum power output of 12 MW in the end of the run. The performance of the channel construction including electrodes and interframe insulators is discussed. The experimental data of the electrical and the comparison between the measured and calculated characteristics of the channel is made. The detailed analysis of the loading scheme of the RM channel and the features of the channel operation at variable load conditions is presented. The data on the electrical nonuniformities and fluctuations and their relation to the channel construction damages are discussed.

3250 Evaluation of the expected diffuser performance for a large MHD generator. (MEPPSCO, Inc, Boston, Mass). pp F.3.1-F.3.6 of Engineering aspects of magnetohydrodynamics, 1978. Brogan, T.R.; Idzorek, J.J.; Swallom, D. Stanford, CA; Stanford Univ. (1978).

From 17. symposium on engineering aspects of MHD; Stanford, CA, USA (27 Mar 1978).

This paper describes an experimental program to evaluate the expected performance of the diffuser for the MHD generator being designed and built by the US for test in the USSR U-25 MHD Facility. The principal novel operating condition is a calculated diffuser inlet blockage of approximately 16%, which is substantially in excess of the blockage for which high subsonic diffuser recovery data is available from previous work.

3251 Kinetic model for molecular contaminant effects in closed cycle, nonequilibrium MHD generators. (GE, Philadelphia, Pa). pp H.1.1-H.1.9 of Engineering aspects of magnetohydrodynamics, 1978. Dellinger, T.C.; Gray, E.L. Stanford, CA; Stanford Univ. (1978).

From 17. symposium on engineering aspects of MHD; Stanford, CA, USA (27 Mar 1978).

The present work involves the development of a theoretical kinetic model for the energy transfer mechanisms pertinent to an inert gas (Ar) - alkali seeded (Cs or K) nonequilibrium plasma containing, either individually or as a mixture, the molecular contaminant species, N_2, CO, CO_2 and H_2O_2. The kinetic formulation includes a description of both the relaxation and the steady-state phenomena. To determine the relaxation effects, the kinetic model is incorporated into an existing quasi-one-dimensional MHD generator flow analysis previously applied to calculate generator performance for comparison with MHD experiments and for use in closed cycle system studies.

FUEL CELLS

3252 (LA—7270-C) Proceedings of the fuel cell in transportation applications workshop. McCormick, B.; Bobbett, R.; Srinivasan, S.; McBreen, J. (eds.). (Los Alamos Scientific Lab., NM (USA)). Jul 1978. Contract W-7405-ENG-36. 142p. (CONF-770892—). Dep. NTIS, PC A07/MF A01.

From Fuel cell powered vehicle workshop; Los Alamos, NM, USA (15 Aug 1977).

Fifteen of the twenty papers were entered in the data base separately; five papers were previously included. The workshop agenda and panel reports are also included in the proceedings. (WHK)

DESIGN AND DEVELOPMENT

3253 (LA—7270-C, pp 31-33) EPRI fuel cell program. Fickett, A. (Electric Power Research Inst., Palo Alto, CA). Jul 1978.

From Fuel cell powered vehicle workshop; Los Alamos, NM, USA (15 Aug 1977).

The EPRI Fuel Cell Program is now three years old, having been initiated by the transfer of project management responsibility for advanced fuel cell technology from an EEI steering committee to EPRI's technical staff (RP114). During this period, critical issues, both technical and nontechnical, have been identified. A comprehensive fuel cell program to address these issues has been formulated.

3254 (LA—7270-C, pp 49-52) CO_2 management for alkaline fuel cell powered electric vehicles. Giner, J. (Giner, Inc., Waltham, MA). Jul 1978.

From Fuel cell powered vehicle workshop; Los Alamos, NM, USA (15 Aug 1977).

Electrolyte carbonation is the principal decay mode of alkaline fuel cells with trapped electrolyte. The performance loss associated with carbonation is caused by a pH gradient caused by carbonate ions accumulating at the anode. The loss is about 75 mV/unit of pH. Carbonation also raises the equilibrium water vapor pressure above the cell. This results in electrolyte volume changes. Finally, the carbonate solubility in the electrolyte is limited. Precipitation of carbonates could lead to crossover. There are three sources of carbonation in the cell. Since air is the oxidant, about 400 ppM CO_2 is delivered to the cell with the air. When a reformed carbonaceous fuel is used as the anode hydrogen source, about 0.33 moles of CO_2 per mole of H_2 is delivered to the cell. This is true for liquid hydrocarbons or methanol fuels. Finally, plastic cell materials may be a source of carbonation. Approaches to removal of CO_2 from the intake air and from the fuel gas stream are discussed. (WHK)

3255 (LA—7270-C, pp 92-95) 1.5 kW indirect methanol-air fuel cell power plant. Onischak, M. (Energy Research Corp., Danbury, CT); Kurpit, S.S. Jul 1978.

From Fuel cell powered vehicle workshop; Los Alamos, NM, USA (15 Aug 1977).

The design and performance of a 1.5 kW methanol fuel cell using phosphoric acid electrolyte, a methanol-steam reformer, and automatic control system are discussed. (WHK)

PERFORMANCE AND TESTING

REFER ALSO TO CITATION(S) 3255

MATERIALS, COMPONENTS, AND AUXILIARIES

REFER ALSO TO CITATION(S) 3254

3256 (LA—7270-C, pp 58-61) Water management and pressurization for fuel cell powered electric vehicles. Bloomfield, D.P. (Giner, Inc., Waltham, MA). Jul 1978.

From Fuel cell powered vehicle workshop; Los Alamos, NM, USA (15 Aug 1977).

For electric vehicles using carbonaceous fuels (i.e., hydrocarbon or methanol), some form of water management is required, if the fuel is reformed in a reactor external to the fuel cell. The water recovery requirements of the powerplant are presented, and three candidate water management systems are discussed. In addition, the general considerations relevant to pressurizing fuel cells are discussed, along with the relative merits of turbocharged pressurization.

APPLICATIONS

REFER ALSO TO CITATION(S) 3256, 3305, 3306, 3307

3257 (LA—7270-C, pp 46-48) Fuel cells for automotive power plants. Baker, B.S. (Energy Research Corp., Danbury, CT). Jul 1978.

From Fuel cell powered vehicle workshop; Los Alamos, NM, USA (15 Aug 1977).

The requirements for fuel cells for use as automotive power plants are discussed, and preliminary specifications for a 10-kW fuel cell automotive power plant are listed. (WHK)

3258 (LA—7270-C, pp 53-57) Status of solid polymer electrolyte fuel cell technology. McElroy, J.F. (General Electric, Wilmington, MA). Jul 1978.

From Fuel cell powered vehicle workshop; Los Alamos, NM, USA (15 Aug 1977).

A brief historical review of the development of solid polymer electrolyte fuel cells is given, and their use in terrestrial electric-powered vehicles is discussed. Reformed fuel/air fuel cells, hydrogen/air fuel cells, and hydrogen/chlorine regenerative fuel cells are considered. (WHK)

3259 (LA—7270-C, pp 73-74) Marketability - an overview. Rahm, A.M. Jul 1978.

From Fuel cell powered vehicle workshop; Los Alamos, NM, USA (15 Aug 1977).

The factors involved in development of a marketable methanol fuel cell/battery hybrid electric-powered automobile are briefly discussed. Capital and operating costs, reliability, product life, safety, mass production manufacturing capability with predictable performance, and industry acceptance are mentioned. (WHK)

3260 (LA—7270-C, pp 122-128) Fuel cells for electric vehicles. Kordesch, K.V. Jul 1978.

From Fuel cell powered vehicle workshop; Los Alamos, NM, USA (15 Aug 1977).

The use and power requirements of fuel cells for electric vehicles are reviewed, and various fuel cell types for vehicle applica-

tions are briefly discussed. Various demonstration vehicles using different fuel cells are discussed. (WHK)

ENERGY CONSERVATION, CONSUMPTION, AND UTILIZATION

REFER ALSO TO CITATION(S) 3176, 3177

BUILDINGS

REFER ALSO TO CITATION(S) 2721, 2822, 3179

3261 (AED-Conf—77-263-002) **Operational experience with electric monovalent heat pumps.** Schwarze,K.H. (Schleswig-Holsteinische Stromversorgungs A.G., Rendsburg (Germany, F.R.)). 1977. 12p. (In German). (CONF-770999—5). Dep. NTIS (US Sales Only), PC A02/MF A01.

From Conference on heat pumps; Essen, F.R. Germany (27 Sep 1977).

A cost comparison is made of the various heating systems, in the context of which the costs and profits of the public utilities come to the fore.

3262 (COO—1340-65) **Modeling the space conditioning energy demand of a community as a function of weather.** Reiter, E.R.; Starr, A.M.; Burns, C.C.; Leong, H.H.; Johnson, G.R. (Colorado State Univ., Fort Collins (USA). Dept. of Atmospheric Science). Sep 1979. Contract EY-76-S-02-1340. 16p. Dep. NTIS, PC A02/MF A01.

A short progress report is given on a highly successful computer model with which we have calculated the daily energy demand during the heating season of Greeley, Colorado, Cheyenne, Wyoming, and Minneapolis, Minnesota. The model is excellently suited to test certain conservation strategies. Preliminary tests of energy demands during the air conditioning season revealed the gross inefficiency of some of the cooling systems presently in operation.

3263 (DOE/EIA—0040(79)) **Typical electric bills: January 1, 1979.** Moscarillo, C. (Department of Energy, Washington, DC (USA). Energy Information Administration). Oct 1979. 202p. Dep. NTIS, PC A10/MF A01.

The report provides comprehensive coverage of the cost to consumers for representative amounts of electricity used per month for residential, commercial, and industrial service in all sections of the nation. Bills for residential electric service are reported for five different energy-consumption levels in all communities with populations of 2500 or more. For commercial and industrial service, bills are presented for all large cities. Commercial bills are shown for 5 combinations of billing demands in kilowatts and monthly consumption levels in kilowatt-hours; industrial bills cover 5 billing demands and 10 consumption levels. Average costs of electricity to American business and residential customers continue to rise over those reported a year earlier, attributed to the continuing rise in fuel costs and the costs of labor, goods, and services to electric utilities. Modifications in basic rate structures and the application of fuel adjustment clauses are other factors affecting the increases. (MCW)

3264 (SAND—78-1927, pp 158-161) **Development of the simulation programs UWENSOL and UWLIGHT for predicting the thermal energy and illumination presences in buildings.** Heerwagen, D.R.; Bedrick, J.R.; Emery, A.F.; Kippenhan, C.J.; Miller, M.S.; Spencer, G.S.; Varey, G.B. (Univ. of Washington, Seattle). 1978.

From Analysis for solar heating and cooling; San Diego, CA, USA (27 Jun 1978).

The two simulation computer programs described here are products of research being performed at the request of the Washington State government. Our State government has initiated a building program for which the reduction of operational energy consumption is to be a deliberate goal. Thus, our research team has been asked to develop guidelines for achieving such ends. We are currently writing these guidelines and testing them via trade-off analyses, that are being conducted with the UWENSOL and UWLIGHT computer programs.

3265 **Environmental/resource assessment and information.** Washington, DC; National Oceanic and Atmospheric Administration (1979). 38p. (NP—24055).

This report is prepared weekly by the Environmental Data and Information Service's Center for Environmental Assessment Services (CEAS), which is an organization within the Department of Commerce, NOAA, and contains a weekly energy assessment entitled Summary of Temperature-Related Energy Consumption, a weekly printout entitled Population-Weighted State Averages of Cooling Degree Days with related descriptive maps, and a weekly printout entitled Population-Weighted Regional and National Cooling Degree Days, with related descriptive maps. Included on a monthly basis, are additional printouts and descriptive maps, with one and three month outlooks, entitled Cooling Degree Summary and Outlook. Meteorological data on which the outlooks are based make use of the entire NOAA long range capability. The one month and three month projected values for cooling degree days are based on the respective one month and three month outlook for average temperatures produced by the National Weather Service Climate Analyses Center. These outlooks have an expected verification of about 60%. Climatology is used to project values for heating degree days and natural gas consumption for the period beyond the forecast.

3266 **Staff report and proposed revisions to appliance efficiency regulations concerning test procedures for central air conditioners.** Sacramento, CA; California Energy Commission (7 Dec 1978). 5p. (NP—24122).

On November 3, 1976, the California Energy Commission adopted appliance efficieny standards for various types of appliances including central air conditioners. The efficiency requirements which became effective on November 3, 1977, were expressed in terms of an energy efficiency ratio (ERR) of 7.0 for all central air conditioners, excluding heat pumps, and were based on test procedures of Air Conditioning and Refrigeration Institute (ARI). On November 25, 1977 the federal government published test procedures for central air conditioners which are somewhat different from those published by ARI in that they include a sampling procedure and are also based on both a steady state EER and a seasonal energy efficiency ratio (SEER). On July 19, 1978, the California Energy Commission adopted an amendment requiring manufacturers to certify the steady state energy efficiency ratio based on the federal method of sampling commencing January 1, 1979. The federal test procedure requires that manufacturers making a representation of the efficiency of central air conditioners on or after January 1, 1979 use the SEER as their measure of efficiency. The July 1978 amendments to the air conditioner efficiency regulations and the modification of these regulations to conform with federal standards and test procedures are described. (LCL)

3267 (LIB-tr—4728) **New generation of energy-saving appliances for heating and domestic hot water supply.** Hahne, J. Translated from *Gas Waerme Int.;* **27**: No. 5-6, 248-252(May 1978). 24p. Dep. NTIS (US Sales Only), PC A02/MF A01.

The demand for wall-mounted circulating-water gas heaters encouraged manufacturers to engage in further development efforts aimed at improving these appliances. The new boilerized unit introduced into the market early in April this year was the outcome of these efforts and gives optimum savings in energy as its heat release is constantly adapted to the heat requirement at any given time. Its design and operation are described. The author also deals with gas water heaters featuring thermostatic control which offer maximum comfort at an average outlet temperature of 60°C and draw-off rates of 21/min and up.

3268 **Regulations for insulating material.** Sacramento, CA; California Energy Commission (1978). 23p. (NP—24121). The Publisher, 111 Howe Ave., Sacramento, CA 95825.

The text of the California Administrative Code, Title 20, Chapter 2, Subchapter 4, Article 3, Standards for Insulating Material (parts 1551 through 1565), is presented. These regulations establish standards governing the quality of insulation material sold or installed within the state after June 4, 1979, including those properties which affect the safety and thermal performance of insulation material during application and in the use intended. (MCW)

RESIDENTIAL BUILDINGS

REFER ALSO TO CITATION(S) 2793, 3180, 3206, 3299

3269 (CONS—2113-T1) **Development of residential buildings energy conservation research, development and demonstration strategies. Final report.** (Hittman Associates, Inc., Columbia, MD (USA)). Aug 1977. Contract EX-76-C-01-2113. 300p. (HIT—681). Dep. NTIS, PC A13/MF A01.

The objectives of the study were to provide detailed information which will assist in planning and establishing priorities for future research, development, and demonstration activities in areas of building energy conservation. Analyses were performed to: (1) identify and prioritize both structural component modifications and climate control systems based on cost impact, energy conservation potential, and regional location; and (2) evaluate the potential of each strategy for mass implementation by considering economic, political and other institutional factors.

3270 (DOE/TIC—10262) **Analysis of residential fuel conservation behavior. Memorandum of findings, appendices, and charts.**

Brown, R.V.; Campbell, V.N.; Repici, D.J. (Decisions and Designs, Inc., McLean, VA (USA)). 3 Oct 1977. 43p. Dep. NTIS, PC A03/MF A01.

From an analysis of consumer surveys and data from trade and industry, Decisions and Designs, Incorporated (DDI) has derived probabilistic estimates of temperature control and insulation responses to energy shortage in US homes. The data collection and analysis include: analysis of a Gallup home survey of 1000 households nationwide; estimating the reporting, non-response and other biases and errors in the Gallup survey; deriving independent estimates of the same target quantities based on a variety of sources (statistical, trade, survey, and power utilities). The sources of error in each approach are quantitatively assessed and combined using the technique of decomposed error assessment and the estimates are pooled to derive single composite estimates and probabilistic margins of error for each target quantity. The main findings and some highlights of the surveys are discussed. (MCW)

3271 (INKA-Conf—79-095-007) **Daily sequence of hot water consumption in private households.** Gossenberger, M. (Elektromark Kommunales Elektrizitaetswerk A.G., Hagen (Germany, F.R.)). 1979. 9p. (In German). (CONF-7905117—5). Dep. NTIS (US Sales Only), PC A02/MF A01.

From Conference on power demand and supply - analysis and strategies; Schliersee, F.R. Germany (16 May 1979).

Hot water consumption in private households is a sphere which strongly varies, mainly because of the subjective influencing factors. Therefore, the data about hot water consumption given in the literature differ also strongly. Nevertheless, there are values with which, taking into consideration the specific characteristics, the dimensioning of systems and profitability calculations are possible. However, the course of hot water preparation, i.e., the temporal course of hot water consumption throughout the day, is still rather unknown. For dimensioning systems as well as for profitability calculations, this daily sequence is also of interest. This is especially valid for the application of new technologies for hot water preparation, such as heat pumps, heat-power coupling, or for the use of solar energy. The efficiency of hot water consumption in households was investigated. Excerpts of these results are reported.

3272 (INKA-Conf—79-095-008) **Power analysis of the heat pump system in Esslingen, Schelztorstrasse.** Bouillon, H. (Forschungsstelle fuer Energiewirtschaft, Muenchen (Germany, F.R.)). 1979. 12p. (In German). (CONF-7905117—6). Dep. NTIS (US Sales Only), PC A02/MF A01.

From Conference on power demand and supply - analysis and strategies; Schliersee, F.R. Germany (16 May 1979).

A river water heat pump system has been operating in Esslingen since the summer of 1976. An extensive measuring program provides data about the performance of the heat pumps and about the energy consumption in the residential area. An important chapter in this total complex of questions is the efficiency analysis, the results of which are shown in the following. It can be said that the efficiency of heat pumps can be described in a sufficiently exact way, can be reconstructed, can even be foretold, as far as the boundary conditions and the influencing factors of the heat pump application are known. This statement can be generalized as tried in these explanations. Thus, heat pumps are distinguished as one of the few end uses of electric power whose performance can be easily calculated.

3273 (NCEI—0002) **Energy and housing: consumer and builder perspectives.** Burby, R.J.; Hernandez, J.T.; Hill, W.W.; Kaiser, E.J.; MacRae, D. Jr.; Marsden, M.E.; McKinney, M.W.; Orr, D.W. (North Carolina Univ., Chapel Hill (USA)). 1979. 396p. NTIS, PC A17/MF A01.

The energy efficiency in new and existing housing in North Carolina, with findings applicable to other states as well, is presented by analyzing the trend toward building for energy efficiency in homes from the perspective of both consumers and builders and policy proposals for state officials are offered. Part One, Energy and Existing Housing, is devoted to the energy efficiency of the existing housing stock and to consumer decisions in the operation of their homes and apartments. Information is provided on fuel use, degree of thermal efficiency, and households' participation in retrofitting tabulated by location, characteristics of the structure, and household characteristics. Part Two, Energy in New Housing, is devoted to three aspects of energy conservation in the production of new homes: characteristics of the market for new housing and consumers' interest in the energy efficiency of their next home; structure of the housing industry and characteristics of home builders as they affect the potential for diffusion of new energy-conservation technologies in the residential sector; and builders' individual decisions to construct houses and neighborhoods incorporating various energy-conservation features. Part Three, Residential Energy Conservation Policy and State Government, explores energy conservation policy as it has evolved across the United States.

3274 (NTIS/PS—79/0232) **Heat pumps (citations from the NTIS data base). Report for 1964-January 1979.** Hundemann, A.S. (National Technical Information Service, Springfield, VA (USA)). Apr 1979. 182p. NTIS PC N01/MF N01.

Technical and economic feasibility of extracting heat from one temperature source and delivering the thermal energy extracted for use at a higher temperature is discussed in abstracts of Federally-sponsored research. Air to air, air-to-water, and water-to-water heat pump systems are covered with reference to residential, commercial, and industrial applications. Performance and reliability studies of heat pumps, including solar assisted heat pumps, for residential heating are emphasized. (This updated bibliography contains 175 abstracts, 81 of which are new entries to the previous edition.)

3275 (NTIS/PS—79/0233) **Heat pumps. Volume 1, 1970-1977 (citations from the Engineering Index data base). Report for 1970-1977.** Hundemann, A.S. (National Technical Information Service, Springfield, VA (USA)). Apr 1979. 249p. NTIS PC N01/MF N01.

Design, performance, and applications of heat pumps are discussed in abstracts from worldwide literature. The heat pumps, which extract heat from one temperature source and deliver the extracted heat for use at a higher temperature, are discussed with regard to their energy conserving potential in residential, commercial, and industrial applications. Air to air, air to water, and water to water heat pump systems are covered. The use of heat pumps, including solar assisted heat pumps, in heating and cooling of buildings and heating of swimming pools is emphasized. (This updated bibliography contains 242 abstracts, none of which are new entries to the previous edition.)

3276 (NTIS/PS—79/0234) **Heat pumps. Volume 2, 1978-January, 1979 (citations from the Engineering Index data base). Report for 1978-January 1979.** Hundemann, A.S. (National Technical Information Service, Springfield, VA (USA)). Apr 1979. 120p. NTIS PC N01/MF N01.

Design, performance, and applications of heat pumps are discussed in abstracts from worldwide literature. The heat pumps, which extract heat from one temperature source and deliver the extracted heat for use at a higher temperature, are discussed with regard to their energy conserving potential in residential, commercial, and industrial applications. Air to air, air to water, and water to water heat pump systems are covered. The use of heat pumps, including solar assisted heat pumps, in heating and cooling of buildings and heating of swimming pools is emphasized. (This updated bibliography contains 113 abstracts, all of which are new entries to the previous edition.)

3277 Analysis and correlation of seasonal performance data from the gas industry's Space Heating Efficiency Improvement Program (SHEIP). Macriss, R.A.; Zawacki, T.S. Chicago, IL; Institute of Gas Technology (1979). 21p. (CONF-790634—5). Institute of Gas Technology, 3424 S. State St., Chicago, IL 60616.

From 72. annual Air Pollution Control Association meeting; Cincinnati, OH, USA (24 Jun 1979).

An account of and results from the US Gas Industry's ongoing program to assess the effectiveness of various retrofit actions to increase the seasonal efficiency of central, gas-fired, space heating, residential furnaces and boilers are presented. This effort, known by the acronym SHEIP (for Space Heating Efficiency Improvement Program), comprises a program of monitoring and data gathering and analysis from over 2000 installations that have been field modified by (1) installation of a vent damper, alone, or with an Intermittent Ignition Device (IID) which replaces the standing gas pilot, (2) installation of a fixed restrictor plate to reduce the free area of the vent-connector pipe, (3) reduction of gas input, with or without secondary air adjustment, etc. This program (now in its third year of operation at IGT, the Institute of Gas Technology) is being participated in by 67 gas utilities monitoring over 2000 installations, and a detailed account of participation, methodologies, and results from these installations is presented with data obtained during the 1977-78 heating season. The results are presented in the form of the energy reduction effectiveness demonstrated by groups of at least 50 sites (similarly retrofit), and in the form of ranges of energy reduction effectiveness of such retrofits, for individual sites.

3278 Air infiltration model for modern single family dwellings. Macriss, R.A.; Cole, J.T.; Zawacki, T.S.; Elkins, R.H. Chicago, IL; Institute of Gas Technology (1979). 21p. (CONF-790634—6).

From 72. annual Air Pollution Control Association meeting; Cincinnati, OH, USA (24 Jun 1979).

A new air infiltration model is presented for single family homes, and more particularly, for homes equipped with central fossil-fuel-fired space heating furnaces. The development of the model, which was based on the results of tests to obtain the contribution of the existence of a chimney, and furnace operation, to house air infiltration, is detailed. The initial tests were carried out in a one-room model home (located within a laboratory) which was equipped with a 5-in. and a 7-in. dia. chimney (20 ft tall), both located outdoors. Most recently, fine-tuning of the model was based on the

results of tests with a 1-story and two 2-story homes, located in the Metropolitan Chicago area. The intensive testing in these homes provides important information regarding the effect, on air infiltration, of such factors as permeability of electrical outlets, vent-fan operation, house buoyancy, wind direction, structural shielding, etc. The precision and utility of the model was verified by simulation of air infiltration in 23 actual homes. Air infiltration levels, and other important variables, have been monitored in these extensive test-homes over a period of nearly 3 y.

COMMERCIAL AND INDUSTRIAL BUILDINGS

REFER ALSO TO CITATION(S) 3275, 3276

3279 (DOE/EIA/2344—1) **Industrial Sector Technology Use Model (ISTUM): industrial energy use in the United States, 1974-2000. Volume 1. Primary model documentation. Book 1: Chapters I, II, and III.** Bohn, R.E.; Herod, J.S. (Energy and Environmental Analysis, Inc., Arlington, VA (USA)). 19 Jun 1978. Contract EX-76-C-01-2344. 270p. Dep. NTIS, PC A12/MF A01.

The model is designed to predict the commercial-market penetration of various energy technologies in the industrial sector out to the year 2000. The model represents the refinement and further development of the Industrial Sector Model developed for the Market Oriented Program Planning Study task force in 1977. The model assesses the comparative economic competitiveness of each technology and then uses these assessments to project each technology's anticipated market penetration. The introductory chapter provides logic and special terminology information of the model. The next sections deal with the input requirements and a discussion of the solution of the model.

3280 (DOE/EIA/2832—1(Vol.1)) **Industrial fuel choice analysis model. Volume I: primary model documentation. First draft.** (Energy and Environmental Analysis, Inc., Arlington, VA (USA)). 8 Jan 1979. Contract EJ-78-C-01-2832. 145p. Dep. NTIS, PC A07/MF A01.

IFCAM is an energy-demand model developed in response to the need to evaluate fuel-choice decisions in the industrial sector over a 10- to 15-year forecasting horizon. The model generates complete model outputs for 1985, 1990, and 1995. These outputs, providing fuel-mix results in either absolute amounts or as distribution percentages, are available under several formats. The fuel-use figures can be presented by new or existing combustors, functional uses (boilers vs process heaters), nine industry sectors, and 10 regions. Boiler results can be broken down by size and capacity utilization. The model can provide outputs related to the cost, tax, and environmental impacts associated with an energy scenario. The basic outputs from the model are oil, gas, and coal demand after all the incentives and fuel-type constraints have been evaluated.

3281 (SAN—1304-T1) **Jolly Tiger Restaurant/Colonie, NY, energy conservation and heat reclamation project. Final report.** (State Univ. of New York, Albany (USA). Atmospheric Sciences Research Center; New York State Assembly Scientific Staff, Albany (USA); Fleming (W.S.) and Associates, Inc., Syracuse, NY (USA)). 15 Aug 1978. Contract EY-76-C-03-1177;EY-76-C-03-1304. 450p. Dep. NTIS, PC A19/MF A01.

The project, from its beginning, has been a team effort between Federal, State, and local agencies. Section I describes the restaurant, its architectural features, mechanical systems, and purpose of the project. Section II describes the Data Acquisition System. Section III assesses the operation and performance of the restaurant as a whole, the several mechanical subsystems which were monitored during the 19 months of the project, and details investigations including baseline tests and human factor analyses. Section IV, Economic and Market Analysis, discusses the interrelationship between system configuration, equipment performance, cost, and the price of energy. It is concluded that, for both large and small restaurant entrepreneurs, implementation of some of the energy-conservation features will benefit the current and future financial environment. It was found that the system with the greatest economic value and minimum capital expenditure is the standard packaged rooftop unit, refrigeration rack, and dishwasher heat exchanger, utilizing LP gas as a supplemental heat source. The system with the greatest energy-conservation value and minimum capital expenditure is the standard packaged rooftop unit with 3000-gallon storage capacity, economizer, MUA Preheat, EARS, Dishwasher HX, and Refrigeration Rack Recovery. If the incremental capital expenditures are within the restaurant's budgetary constraints, the system with the greatest energy conservation value is the twin heat pump system with 3000 gallons storage and the same subsystems as above. Section IV also includes a market analysis of the energy-conservation and heat-reclamation systems. In Section V, Operational and Maintenance Experience and Equipment Modification are discussed and design and operational suggestions for restaurant designers and operators are given. Six Appendices supplement the information contained in the report.

TRANSPORTATION

AIR AND AEROSPACE

3282 **Energy usage and UK industry.** Berrie, T.W.; Leslie, D. (Preece, Cardew and Rider, Brighton, United Kingdom). *Electr. Rev. (London)*; **203**: No. 6, 28-29(11 Aug 1978).

The industrial sector in the UK is the greatest consumer of energy. Fuel consumption, prices, and future requirements are examined for the iron and steel and manufacturing industries. The continued rising of prices and prospects for all fuels are discussed along with measures for energy savings. (MCW)

RAILWAY

3283 (NTIS/PS—79/0189) **Railroad freight transportation. Volume 2, 1975-February, 1979 (a bibliography with abstracts). Report for 1975-February 1979.** Kenton, E. (National Technical Information Service, Springfield, VA (USA)). Mar 1979. 247p. NTIS PC N01/MF N01.

The citations deal with economic impacts, intermodal systems, energy studies, scheduling, rolling stock utilization, rail revitalization, accident studies, cost analyses, and characteristics within specific regions. The bibliography also covers freight car design, engineering, and testing programs as well as train engineering and operations. (This updated bibliography contains 239 abstracts, 89 of which are new entries to the previous edition.)

LAND AND ROADWAY

REFER ALSO TO CITATION(S) 3301

3284 (DOE/CS/50063—1) **Vanpooling: the three major approaches.** Sears, P.M. (Department of Energy, Washington, DC (USA). Office of Conservation and Solar Applications). Aug 1979. Contract AP01-79CS50063. 102p. Dep. NTIS, PC A06/MF A01.

The manual provides technical assistance to existing or prospective vanpool sponsors. It is designed to help them promote vanpooling in its three major approaches: employer sponsored, third party sponsored, and driver owned and operated. The first chapter is an overview of vanpooling and a second chapter, on vanpool marketing, is addressed to ridesharing coordinators and others whose responsibilities include the promotion of vanpooling. Some fact sheets on the three approaches provide convenient summaries of the needs and opportunities of each approach and suggest solutions to practical problems likely to be encountered in starting new vanpool programs.

3285 (UCRL—52697) **Methanol as a transportation fuel: assessment of environmental and health research.** Timourian, H.; Milanovich, F. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 18 Jun 1979. Contract W-7405-ENG-48. 97p. Dep. NTIS, PC A05/MF A01.

This report evaluates the current status of knowledge on the health and environmental impacts resulting from the use of methanol and methanol-gasoline blends as automotive fuels. The report contains a review of the physical and technical background on methanol as an automotive fuel, a comprehensive review of the environmental, biological, and human health effects associated with the impact of methanol use and production, an outline of the main issues that must be resolved by further research programs, and recommended research to address the main issues. A large bibliography is included. (MCW)

SEA AND WATER

3286 (SAN—1175-T2(Vol.3)) **Energy use in the marine transportation industry: Task II. Regulations and Tariffs. Final report, Volume III.** (Booz, Allen and Hamilton, Inc., Bethesda, MD (USA)). Dec 1977. Contract EY-76-C-03-1175. 108p. Dep. NTIS, PC A06/MF A01.

The evaluation of the energy impacts of regulations and tariffs is structured around three sequential steps: identification of agencies and organizations that impact the commercial marine transportation industry; identification of existing or proposed regulations that were perceived to have a significant energy impact; and quantification of the energy impacts. Following the introductory chapter, Chapter II describes the regulatory structure of the commercial marine transportation industry and includes a description of the role of each organization and the legislative basis for their jurisdiction and an identification of major areas of regulation and those areas that have an energy impact. Chapters III through IX each address one of the 7 existing or proposed regulatory or legislative actions that have an energy impact. Energy impacts of the state of Washington's tanker regulations, of tanker segregated ballast requirements, of inland waterway user charges, of cargo pooling and service rationalization, of the availability of intermodal container transportation

services, of capacity limitations at lock and dam 26 on the Mississippi River and the energy implications of the transportation alternatives available for the West Coast crude oil supplies are discussed. (MCW)

PIPELINE

REFER ALSO TO CITATION(S) 2456

INDUSTRY AND AGRICULTURE

REFER ALSO TO CITATION(S) 3279, 3280

3287 (DOE/TIC—10002) **Development of the strategic plan for Industrial Energy Conservation.** (Department of Energy, Oak Ridge, TN (USA). Technical Information Center). Jul 1978. 40p. Dep. NTIS, PC A03/MF A01.

A strategic plan for the Federal industrial energy conservation research, development, and demonstration program is discussed. A strategic plan must reflect the external environment in which the program operates and must be responsive to changing events. An executive summary highlights reasons for Federal concern about industrial energy use, barriers to greater efficiency in industrial energy use, alternative Federal roles in industrial energy conservation, and Federal strategy. Chapter I identifies and evaluates the major constraints to accelerating the rate of industrial energy conservation; also, alternative Federal strategies are identified. Chapter II present assessments that lead to overall strategies for Federal programs as well as to specific strategies in R, D, and D programs in industrial energy conservation. The basis used for these assessments is overall national energy policy. (MCW)

ENERGY SOURCES

REFER ALSO TO CITATION(S) 2924

3288 (STU—76-3410AB) **Energy demand for the fatigue of wet wood at different temperatures.** Fellers, C. (Styrelsen foer Teknisk Utveckling, Stockholm (Sweden)). Mar 1979. 11p. (In Swedish). Dep. NTIS (US Sales Only), PC A02/MF A01.

The defibering process for wet wood was simulated. Equipment for material testing was installed which produces cyclic loading of a test assembly of wood possible under well defined conditions of loading. In this project the dynamic properties of wet wood were studied as well as the fatigue sensitivity at different levels of deformation, different frequencies, temperatures and chemical environments. The fatigue properties of wood were studied with shear loading parallel to the fiber direction. The temperature and the stress amplitude were varied. The results show that the wood was mostly insensitive to fatigue at cyclic loads below 10^8 cycles. Thus most of the supplied energy was converted to heat without introducing cracks in the structure.

EQUIPMENT AND PROCESSES

3289 (COO—4397-T3) **Design of data acquisition and control systems for environmental monitoring and microclimate control.** Fuoco, D.P. (Pennsylvania State Univ., University Park (USA)). 1979. Contract EC-77-S-02-4397. 83p. Dep. NTIS, PC A05/MF A01.

Thesis.

Modern fruit growing techniques rely heavily on automated control equipment to improve yields and reduce operating expenses. This thesis is part of a long term project whose ultimate goal is the automation and optimization of fruit production. This thesis describes the equipment that has been developed to date. Also presented is a brief methodology that considers how this equipment came to be. It should be noted that there are many related uses for climate control, most of which could make good use of this same type of equipment. In fact, any physical process that requires close supervision of the natural elements is a prime candidate for this type of endeavor.

3290 (DOE/CS/40234—3) **Demonstration of a nitrogen based carburizing atmosphere. Third quarterly report, 1 April-30 June 1979.** Peartree, R.J. (Air Products and Chemicals, Inc., Allentown, PA (USA)). Sep 1979. Contract EM-78-C-01-5058. 17p. Dep. NTIS, PC A02/MF A01.

Energy consumption tests have been completed on a Radiant Tube Box (RTB) furnace which has a fibrous insulation. On this furnace an average of 9.7% of the energy used in processing parts with the conventional endothermic atmosphere practice was saved using nitrogen based atmosphere systems. Furthermore, the natural gas required at the heat treating facility to process the parts was reduced an average of 28.7%. Energy consumption of the furnace while idling under a methanol atmosphere was determined. When combined with the earlier reported data on endothermic and pure nitrogen atmospheres, a linear relationship between energy consumption and hydrogen concentration of the furnace atmosphere was found.

3291 (INKA-Conf—79-171-001) **Examples of efficient use of energy in medium-sized industrial plants.** Mann, E.W. (Rheinisch-Westfaelisches Elektrizitaetswerk A.G., Essen (Germany, F.R.). Abt. Anwendungstechnik). 1979. 38p. (In German). (CONF-7906137—002). Dep. NTIS (US Sales Only), PC A03/MF A01.

From Lecture meeting on optimized energy economy in industry; Essen, F.R. Germany (5 Jun 1979).

Some examples are given to show how a process step may be replaced by another in which less energy is consumed. Examples are the heating of welded parts (conductive instead of inductive), paper drying (high-frequency drying), and a change in heat utilization in dairies. Possibilities of efficient energy use by means of heat pumps are illustrated by the examples of wood desiccation (condensation drying), heating of a factory floor, flue gas waste heat utilization for space and water heating and in galvanization.

3292 (LBL—8580, pp 487-503) **Conservation.** 1978.

In Materials and Molecular Research Division annual report, 1978.

Progress is reported in research on an engineering analysis of gas evolution in electrolysis and on improving the efficiency of electrochemical cells for converting chemical energy to electrical energy in galvanic cells and in the production of materials by electrolysis. (LCL)

WASTE HEAT RECOVERY AND UTILIZATION

REFER ALSO TO CITATION(S) 3099, 3100, 3121, 3122, 3123, 3174, 3291

INDUSTRIAL WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 2384, 2430

3293 (DOE/EV—0046(Vol.1), pp 334-370) **Subsurface disposal of oilfield brines and petrochemical wastes.** Donaldson, E.C. (Dept. of Energy, Bartlesville, OK). Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

The injection of wastes into deep underground formations is the most economical method for disposal of liquid wastes that are not amenable to surface treatment. Operating costs are lower for pretreatment and subsurface disposal than for surface treatment systems, and plant area requirements are less. Chemical treatment is minimal, and generally the only physical treatment required is filtration. This report presents a broad view of modern industrial underground waste injection systems and their operations. The types of wastes being injected and the major features of equipment, geologic formations, and well operation are described. The petroleum industry has been injecting fluids into subsurface formations for many years; therefore, many of the techniques and much of the equipment for handling industrial liquid wastes are already available or can be modified to meet the specialized requirements. The techniques for drilling and completing the disposal wells have been perfected. Similarly the behavior of fluid flow through porous rocks and unconsolidated sand has been investigated; therefore, many of the theories and equations describing the fluid distributions have been proved. Modification may, however, be needed to make them applicable to waste injection systems and to describe the radial chromatographic properties of the injected wastes constituents. A subsurface disposal system can be successful only if a porous, permeable formation of wide areal extent is available at sufficient depth to ensure safety in storage and retention of the injected fluids. The wastes usually are treated for solids removal and compatibility with the formation. An impermeable zone, such as shale or evaporite, must overlie the injection horizon to prevent vertical migration of the waste or displaced formation brines into low-salinity aquifers above the disposal zone.

MUNICIPALITIES AND COMMUNITY SYSTEMS

3294 (DOE/TIC—10201(Vol.2)) **Phase I. Integrated community energy plan for Riverside, California. Final report.** (Battelle Columbus Labs., OH (USA)). Jan 1979. Contract W-7405-ENG-92. 357p. Dep. NTIS, PC A16/MF A01.

Many technical aspects must interact closely and be integrated with pertinent socio-economic, institutional, and legal aspects in the development of an integrated community energy plan. The key elements of this development are shown and discussed in Appendix A: Overall Methodology for Developing an Integrated Community Energy Plan for Riverside, California. Appendix B characterizes energy consumption and needs of that community. Extensive energy

conservation options are developed and described in Appendix C. Sectors covered are buildings, industry, transportation, and community design. (MCW)

3295 (INKA-Conf—79-080-001) **International Energy Agency: balance and outlook.** Lantzke, U. (International Atomic Energy Agency, Vienna (Austria)). 1979. 3p. (In German). (CONF-7904110—3). Dep. NTIS (US Sales Only), PC A02/MF A01.

From 2. symposium on the mineral resources potential of the earth; Hannover, F.R. Germany (18 Apr 1979).

3296 (ORNL/TM—6830/P6) **District heating/cogeneration application studies for the Minneapolis-St. Paul Area.** Yeoman, J.C. (Oak Ridge National Lab., TN (USA)). Oct 1979. Contract W-7405-ENG-26. 46p. Dep. NTIS, PC A03/MF A01.

As part of a series of studies on the institutional and technical aspects of cogeneration and district heating, a net energy analysis has been performed on three systems for providing space heating, space cooling, domestic hot water, and domestic electricity for an idealized community located in a climate similar to that of Minneapolis, Minnesota. The three systems are an all-electric system, a gas-electric system, and a cogeneration-district heating system. The capital and operating energy costs were determined, and a life cycle energy cost analysis was performed. Results of the life cycle energy cost analysis show that the cogeneration-district heating system consumes about half as much primary energy as the all-electric system and four-fifths as much primary energy as the gas-electric system. In the gas-electric and all-electric systems, coal provides 39% and 70%, respectively, of the operating energy. Coal provides 76% of the annual operating energy for the district heating system. Because the district heating system consumes primarily coal rather than scarce and more expensive crude oil and natural gas, it depends less on foreign sources of fossil fuel.

PUBLIC UTILITIES

REFER ALSO TO CITATION(S) 2484, 3174

3297 (ANL/CNSV-TM—8) **Heat-Pump-Centered Integrated Community Energy Systems: system development. Final report.** Dubin, F.S.; Halfon, A.; Herzog, P. (Dubin-Bloome Associates, New York (USA)). Aug 1979. Contract W-31-109-ENG-38. 442p. Dep. NTIS, PC AA19/MF A01.

The ice-generating HP-ICES uses the heat of fusion of water as a heat source for the heat pump, thus converting the water into ice. The ice will be stored in a bin and used the following summer for cooling which, therefore, could be considered a by-product of heating. The annual overall Coefficient of Performance is expected to reach a value of 4.85 and related to source energy a value of 4.85 x 0.31 = 1.5. In a detailed case study on the Market Square project in Washington, D.C., it was found that for the HP-ICES the annual source energy input is about 60% and the life cycle annual average cost is 40% of the corresponding quantities for a conventional central system with equal heating and cooling capacity. The annual average operating and administration cost for the HP-ICES is less than 70% of the corresponding costs for the conventional system, while the first cost of the HP-ICES is about 70% larger than the first cost of the conventional system. With the values assumed for the discount rate, interest rate, etc., the return on investment was found to be about 15%, which gives a discounted payback period of about 6.7 years. For the Park Plaza in Boston, The annual source energy input for the HP-ICES is 35% and the energy cost is about 30% of the corresponding quantities for the conventional system. The annual average operating and administration cost for the HP-ICES is 4.5 times as great as the first cost for the conventional system. The return on investment is 13% and the payback is 8 years. These results show that the HP-ICES can be better both in energy usage and in life cycle cost than a conventional system of the same heating and cooling capacity, and holds great promise as an energy saving system.

3298 (INKA-Conf—79-095-005) **Problems of peak demands in the gas industry.** Haeberlin, A. (Ruhrgas A.G., Essen (Germany, F.R.). Abt. E-F). 1979. 16p. (In German). (CONF-7905117—3). Dep. NTIS (US Sales Only), PC A02/MF A01.

From Conference on power demand and supply - analysis and strategies; Schliersee, F.R. Germany (16 May 1979).

After a brief explanation of the demands made on gas supply enterprises, a discussion of the possibilities of optimization for meeting the demand follows. There are in principle two possibilities for this: the interruption of deliveries which should be made legal in a contract and the use of peak supply plants, especially in the form of gas storages. The procedure is chosen according to the special situation of each gas supply enterprise.

MUNICIPAL WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 3527

EDUCATION AND PUBLIC RELATIONS

REFER ALSO TO CITATION(S) 3162, 3180, 3270

3299 (DSE—8702-T2) **Project monitor. Final report.** Hammond, P.Y.; Beck, P.; Doctors, S.I. (Pittsburgh Univ., PA (USA). Research Inst. for Energy Policy). 27 Apr 1979. Contract EM-77-C-01-8702. 341p. Dep. NTIS, PC A15/MF A01.

Portions of document are illegible.

Results are reported of a study of consumers' energy attitudes and behavior. Household consumers and small business consumers (both retail and manufacturing) responded to the survey, but only the household results are reported. The study sought to understand energy-related behavior at the level where the various components of energy policy intersect. Attempts are made to attain this goal by determining the extent to which various properties of the individuals and firms are associated with various amounts of conservation. A representative sample of the adult population in Allegheny County, Pennsylvania was interviewed. Part I introduces the measures of household conservation to be used in the survey. Part II analyzes each of the types of energy conservation - general, winterization, heating, cooling, appliance, transportation, and electricity reductions - and relates them to demographic, situation, attitudinal, and perceptual variables in the household sample. Part III deals with the impacts of Project Pacesetter and the United Mine Workers' strike against the coal operators - particularly, the impact of the coal strike on household residents of Allegheny County. Part IV summarizes the findings and uses them for recommendations regarding energy conservation policy. Additional data are presented in 4 appendices. (MCW)

ADVANCED AUTOMOTIVE PROPULSION SYSTEMS

INTERNAL COMBUSTION ENGINES

DIESEL

3300 (DOE/EV—0046(Vol.2), pp 429-444) **Environmental control technology for mobile diesel engines.** Kebely, V.; Fullenwider, E.D.; Tomlinson, J.C. (The Aerospace Corp., Germantown, MD). Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

An analysis was conducted during May and June, 1978, by the Aerospace Corporation for the Department of Energy (DOE) Division of Environmental Control Technology to provide an overview of diesel emissions characterizations, control technology and health effects. It was based on reviews of published data, computer searches of research project inventories, discussions with both federal and private sector organizations, and information from the joint Department of Transportation (DOT)/Department of Energy (DOE)/Environmental Protection Agency (EPA) workshop in Washington, DC (27 and 28 April 1978) and the EPA symposium in Ann Arbor, MI, (17-19 May 1978). An executive summary of the study final report is presented which: identifies relevent issues; summarizes past and current research; indicates broad areas of research needs; contains a bibliography of documents reviewed, organized by sponsoring agencies and providing brief notation on the objective and scope of the research reported; and lists relevent ongoing research as extracted from the Federal Inventory of Energy Related Environmental and Safety Research, and the Smithsonian Scientific Information Exchange. The list includes a summary of the number of projects and funding for each research category.

3301 (DOE/EV—0050/1) **Issues concerning the light-duty diesel.** (Department of Energy, Washington, DC (USA). Office of Technology Impacts). Sep 1979. 145p. Dep. NTIS, PC A07/MF A01.

The current reasons for concern about the diesel engine for light-duty vehicles are explained, and an overview of the major issues impacting upon future diesel-related policy considerations is presented. Light-duty diesels are of immediate concern because proposed environmental legislation could impact upon their market future as early as model year 1981. The environmental issues affecting these vehicles also have implications for other categories of diesels (heavy-duty mobile and stationary application). Part I presents background and overview information on the reasons for the diesel's emergence as a major concern in the regulatory area and Part II summarizes the issues surrounding the diesel in three major areas: protecting health and the environment; fuel conservation; and broad economic and programmaic trade-offs arising from the previous two areas.

TURBINE

3302 (BMFT-FB-T—78-51) **Development of high-temperature resistant, noncorrosible, nonmetallic ceramic materials, especially silicon nitride for heat exchangers in gas turbine application.** Schindler, S.R.; Krauth, A. (Rosenthal Technik A.G., Selb (Germany, F.R.)). Dec 1978. 84p. (In German). Dep. NTIS (US Sales Only), PC A05/MF A01.

The report is part of the project Ceramic Materials for Automobile Gas Turbines, which has been sponsored by the Ministry for Research and Technology of the Federal Republic of Germany since 1974. Special effort has been made in the development of silicon nitride, suitable production techniques as well as the production of heat exchanger prototypes and gas turbine components. Tight connection of production techniques, construction and testing in simulated application conditions made it possible to transfer the material data from test specimens to structural components. Combustion chambers and stators were produced and tested. The results in heat exchanger development concerning permeability, thermal and mechanical loading are promising and speak for a successful continuation of the R and D project.

EXTERNAL COMBUSTION ENGINES

REFER ALSO TO CITATION(S) 3115

ELECTRIC-POWERED SYSTEMS

REFER ALSO TO CITATION(S) 3138, 3254, 3256, 3257, 3258, 3260, 3306

3303 (DOE/EV—0046(Vol.2), pp 411-427) **Safety attention in the DOE Near-Term Electric Vehicle Program.** Walker, G.J. (Dept. of Energy, Washington, DC). Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

In September 1976 the Congress of the United States enacted Public Law 94-413, the Electric and Hybrid Vehicle Research, Development, and Demonstration Act of 1976. In this Act the Congress declared that the nation's dependence on foreign sources of petroleum must be reduced, as such dependence jeopardizes the national security, inhibits foreign policy, and undermines economic well-being. The intent of the Act is to accelerate the development and demonstrate the commercial feasibility of electric and hybrid vehicles through government-sponsored research and development, demonstrations and financial incentives. The Department of Energy (DOE) is responsible for implementing the requirements of the Act. One of the major DOE funded R and D activities underway in response to the Act is the Near-Term Electric Vehicle (NTEV) Program. This program addresses the nation's largest single user of petroleum; the passenger car. The NTEV Program is addressing the total vehicle as a system and the complete spectrum of requirements placed on the automobile (e.g., utility, producibility., affordability, safety) are being considered. The program is focused on the actual design, development, and fabrication of complete integrated test vehicles. The concerted attention being given to assuring that these vehicle designs incorporate features that are conducive to safe vehicle operation and maintenance is described. These safety features are required to provide for non-operating safety (e.g., battery charging), crash avoidance (e.g., braking and handling) and crash energy management (e.g., crashworthiness and occupant protection).

3304 (DOE/JPL/152170—1) **Review of composite material applications in the automotive industry for the electric and hybrid vehicle. Annual report, November 1978.** Bauer, J.L. (Jet Propulsion Lab., Pasadena, CA (USA)). Jul 1979. Contract EM-78-I-01-4209. 92p. Dep. NTIS, PC A05/MF A01.

A comprehensive review is made of the state-of-the-art in regard to the use of composite materials for reducing the structural mass of automobiles. Reduction of mass will provide, in addition to other engineering improvements, increased performance/range advantages that are particularly needed in the electric and hybrid vehicle field. Problems to be overcome include the attainment of mass production techniques and the prevention of environmental hazards.

3305 (LA—7270-C, pp 67-72) **Computer technology and the fuel cell vehicle program.** Gore, R.A. (Los Alamos Scientific Lab., NM). Jul 1978.

From Fuel cell powered vehicle workshop; Los Alamos, NM, USA (15 Aug 1977).

The role of current computer technology in an integrated systems approach to the design of a prototype fuel cell powered electric vehicle is discussed. Four areas of the development program in which computer technology can be employed are discussed. These include 1) modeling and simulation of the components and the total system, 2) laboratory testing of components and test data analysis, 3) data acquisition and recording of the vehicle parameters, and 4) the implementation of the control systems for the prototype vehicle. (WHK)

HYBRID SYSTEMS

REFER ALSO TO CITATION(S) 3257, 3259, 3260, 3303, 3304

3306 (LA—7270-C, pp 62-66) **Hybrid fuel cell/battery electric vehicle instrumentation.** Findl, E. (ARK Research, Farmingdale, NY). Jul 1978.

From Fuel cell powered vehicle workshop; Los Alamos, NM, USA (15 Aug 1977).

Instrumentation required for a fuel cell/battery hybrid electric vehicle is reviewed. Instrumentration for the various components including the propulsion battery, motor, speed controller, fuel cell, auxiliary electrical system, reformer, battery charger, fuel tank, and drive train is discussed. (WHK)

3307 (LA—7270-C, pp 104-114) **Hybrid power source for material handling equipment.** O'Sullivan, J.B.; Dowgiallo, E.J.; Snellings, I.R. (Army Mobility Equipment R & D Center, Fort Belvoir, VA). Jul 1978.

From Fuel cell powered vehicle workshop; Los Alamos, NM, USA (15 Aug 1977).

A hybrid power source is composed of differing power sources that operate in parallel, i.e., load share, into a common demand. These hybrid power sources are designed to optimize some set of characteristics (size, weight, performance, efficiency, etc.), which are not met with either component power source. Material handling equipment (MHE) applications have load profiles that indicate hybrid power sources may be advantageous for improved performance and efficiency. The profiles of some MHE applications have been analyzed and used for design of a hybrid power source composed of a fuel cell and a battery. This hybrid is being constructed for installation in an electric fork lift truck. Preliminary bench testing is yielding quantitative data on the interactions and performance of the present components.

WEIGHT

REFER ALSO TO CITATION(S) 3304

EMISSION CONTROL

REFER ALSO TO CITATION(S) 3300

3308 (NTIS/PS—79/0226) **Automobile air pollution: automotive fuels (a bibliography with abstracts). Report for 1970-March 1979.** Cavagnaro, D.M. (National Technical Information Service, Springfield, VA (USA)). Mar 1979. 143p. NTIS PC N01/MF N01.

The use of fuels and fuel additives to reduce pollution from automobiles is covered in this bibliography. The use of methyl alcohol, natural gas, methane, and hydrogen is reported. Improvements to gasoline and its properties which affect air pollution are discussed, along with studies on lead additives. (This updated bibliography contains 137 abstracts, 33 of which are new entries to the previous edition.)

3309 (NTIS/PS—79/0227) **Automobile air pollution: abatement through management and planning (a bibliography with abstracts). Report for 1970-March 1979.** Cavagnaro, D.M. (National Technical Information Service, Springfield, VA (USA)). Mar 1979. 260p. NTIS PC N01/MF N01.

Planning and management studies for the abatement of air pollution from automobiles are covered. This includes reports on maintenance and inspection programs, emission factors, urban planning related to pollution, Government policies, and the effects of these strategies on citizens and on urban growth. Reports which give background information pertinent to such abatement decisions are also cited. (This updated bibliography contains 254 abstracts, 31 of which are new entries to the previous edition.)

3310 (NTIS/PS—79/0245) **Automobile air pollution: new automotive engines and engine improvements. Volume 1. 1970-1977 (a bibliography with abstracts). Report for 1970-1977.** Habercom, G.E. Jr. (National Technical Information Service, Springfield, VA (USA)). Apr 1979. 185p. NTIS PC N01/MF N01.

This bibliography cites reports on new designs of automobile engines. The engine types include gas turbines, stratified charge engines, steam engines, hybrid engines using electric motors or flywheels, and rotary engines. Many of these studies also cover the problem of improving fuel economy while lowering emissions. Ret-

rofit devices are excluded. (This updated bibliography contains 176 abstracts, none of which are new entries to the previous edition.)

3311 (NTIS/PS—79/0246) **Automobile air pollution: new automotive engines and engine improvements. Volume 2. 1978-March, 1979 (a bibliography with abstracts). Report for 1978-March 1979.** Habercom, G.E. Jr. (National Technical Information Service, Springfield, VA (USA)). Apr 1979. 109p. NTIS PC N01/MF N01.

This bibliography cites reports on new designs of automobile engines. The engine types include gas turbines, stratified charged engines, steam engines, hybrid engines using electric motors or flywheels, and rotary engines. Many of these studies also cover the problem of improving fuel economy while lowering emissions. Retrofit devices are excluded. (This updated bibliography contains 100 abstracts, 94 of which are new entries to the previous edition.)

ALTERNATIVE FUELS

REFER ALSO TO CITATION(S) 3308

3312 (COO—4486-5) **Flame propagation, autoignition and combustion in alcohol-petroleum-air mixtures and other alternative fuels. Final report, August 1, 1977-December 31, 1978.** Henein, N.A. (Wayne State Univ., Detroit, MI (USA)). Sep 1979. Contract EC-77-S-02-4486. 10p. Dep. NTIS, PC A02/MF A01.

The main goal of this program is to determine the combustion characteristics of the future alternative fuels in gasoline, diesel engines so that future combustion engines may be designed for best energy conversion and minimum emissions. The approach consists of studying the process of combustion in actual engines to obtain data needed to either design new engines or modify and adapt existing engines to the alternative fuels. This includes both experimental and theoretical work. The experimental work consists of instrumenting and running tests on three research engines and measuring the different combustion characteristics. The theoretical work includes calculating and correlating the flame speed and ignition delay with different fuel and air properties and engine operating parameters. New techniques have been developed to determine the combustion characteristics of fuels. Traveling ionization probe to measure the flame arrival time at different locations in the combustion chamber of gasoline engines without interrupting their operation. A new mechanism to sample the combustion products at any point in the cycle and measure the NO and particulate formation. Sampling the gases during the ignition delay period will help us to understand the source of odorous emissions and to solve such problems as cold starting and noise in the diesel engine when it is run on low ignition quality alternative fuels. In addition, a modified Cetane Scale has been developed to rate the auto ignition properties of alternate low cetane fuels.

MATERIALS

REFER ALSO TO CITATION(S) 2413

3313 (LBL—8580) **Materials and Molecular Research Division annual report, 1978.** (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). 1978. Contract W-7405-ENG-48. 513p. Dep. NTIS, PC A22/MF A01.

Research is presented concerning materials science including metallurgy and ceramics; solid state physics; and materials chemistry; chemical sciences covering radiation science, chemical physics, and chemical energy; nuclear science; coal research; solar energy; magnetic fusion, conservation; and environmental research. (FS)

METALS AND ALLOYS

REFER ALSO TO CITATION(S) 2383, 2389, 2390

3314 (LBL—8580, pp 7-219) **Materials sciences.** 1978. In Materials and Molecular Research Division annual report, 1978.

Progress in research in structure of materials, mechanical and physical properties, solid state physics, and materials chemistry, including chemical structure, high temperature and surface chemistry is reported. (FS)

3315 (NTIS/PS—79/0220) **Superalloys. Volume 2. 1977-February, 1979 (citations from the NTIS data base). Report for 1977-February 1979.** Reed, W.E. (National Technical Information Service, Springfield, VA (USA)). Mar 1979. 126p. NTIS PC N01/MF N01.

Federally-funded research on cobalt- and nickel-based superalloys is cited. Casting and powder metallurgy of these alloys are covered. Properties such as heat resistance, corrosion resistance, microstructure, fracture, and creep are described. The use of these materials in nuclear reactors, gas turbine parts, and high temperature equipment is a major part of this compilation. (This updated bibliography contains 120 abstracts, 33 of which are new entries to the previous edition.)

3316 (NTIS/PS—79/0221) **Superalloys. Volume 3. March, 1977-February, 1979 (citations from the Engineering Index data base). Report for March 1977-February 1979.** Reed, W.E. (National Technical Information Service, Springfield, VA (USA)). Mar 1979. 277p. NTIS PC N01/MF N01.

Worldwide research is cited on cobalt-, iron-, and nickel-based superalloys. The manufacture, melting, casting, powder metallurgy, forging, and welding of these alloys are covered. Studies on corrosion, high and low temperature properties, physical, and mechanical properties of these materials are included. Applications discussed include nuclear reactors, gas turbines, superconducting machinery, and heat exchangers. (This updated bibliography contains 271 abstracts, 100 of which are new entries to the previous edition.)

PREPARATION AND FABRICATION

REFER ALSO TO CITATION(S) 3001, 3143

3317 (FE—2606-T1) **Development of automated welding processes for field fabrication of thick-walled pressure vessels: electron beam method. Sixth quarterly report, January 1-March 31, 1979.** Weber, C.M. (Babcock and Wilcox Co., Alliance, OH (USA). Research and Development Div.). 1979. Contract EF-77-C-01-2606. 34p. Dep. NTIS, PC A03/MF A01.

Research is reported of a project to develop and demonstrate an electron beam welding procedure for welding 8" thick SA 387 Grade 22 Class 2 (2-1/4 Cr-1 Mo) steel. A total of 414 welds have been made to date. Partial penetration welding procedures capable of producing defect-free, 4" welds have been developed in the horizontal position. Beam oscillation conditions strongly influence welding performance. Defect-free, partial penetration welds have been made at vacuum pressures of up to 30 microns. Several 8" thick, defect-free welds have been made in the horizontal position. Attempts to produce defect-free, partial penetration welds in the vertical position have been unsuccessful.

3318 (INKA-Conf—78-233-001) **Properties and control of heat-treatment furnace atmospheres working without generator.** Goehring, W. (Ipsen Industries International G.m.b.H., Kleve (Germany, F.R.)). 1978. 13p. (In German). (CONF-7810198—1). Dep. NTIS (US Sales Only), PC A02/MF A01.

From 3. hardening shop colloquium on materials and heat treatment; Wiesbaden, F.R. Germany (4 Oct 1978).

The potential of an oxygen probe represents the carbon level of a furnace atmosphere even if no chemical equilibium among the gases in the furnace chamber is reached. Based on this new knowledge, the fuel/air mixture may be supplied directly into the furnace chamber if the probe is applied. A furnace atmosphere with heavily increased supply of carbon has got a correspondingly high speed of carburization and results in a very uniform hardening layer at all points of the workpiece and the charge. Taking into account this realization a carburization cycle where at first natural gas or propane is fed into the furnace chamber is reported. The carbon supply is controlled by means of the CH_4 share of the furnace atmosphere. Following the carburization process air reacts with the carbon and removes it. Thereby the carbon level is controlled by changing the flow rate of air. The described furnace atmospheres working without generator are characterized by very short carburization times and excellent quality of the hardening layer.

3319 (LBL—9435) **Advances in the heat treatment of steels.** Morris, J.W. Jr.; Kim, J.I.; Syn, C.K. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jun 1978. Contract W-7405-ENG-48. 50p. (CONF-780725—2). Dep. NTIS, PC A03/MF A01.

From 25. conference on recent advances in metals processing; Bolton Landing, NY, USA (17 Jul 1978).

A number of important recent advances in the processing of steels have resulted from the sophisticated uses of heat treatment to tailor the microstructure of the steels so that desirable properties are established. These new heat treatments often involve the tempering or annealing of the steel to accompish a partial or complete reversion from martensite to austenite. The influence of these reversion heat treatments on the product microstructure and its properties may be systematically discussed in terms of the heat treating temperature in relation to the phase diagram. From this perspective, four characteristic heat treatments are defined: (1) normal tempering, (2) intercritical tempering, (3) intercritical annealing, and (4) austenite reversion. The reactions occurring during each of these treatments are

described and the nature and properties of typical product microstructures discussed, with specific reference to new commercial or laboratory steels having useful and exceptional properties.

3320 (Y—2165(Rev.)) **Inertia and friction welding of aluminum alloy 1100 to type 316 stainless steel.** Perkins, M.A. (Oak Ridge Y-12 Plant, TN (USA)). 19 Oct 1979. Contract W-7405-ENG-26. 27p. Dep. NTIS, PC A03/MF A01.

The inertia and friction-welding processes were evaluated for joining aluminum alloy 1100-H14 and Type 316 vacuum-induction melted, vacuum-arc remelted (VIM VAR) stainless steel. While both processes consistently produced joints in which the strength exceeded the strength of the aluminum base metal, 100 percent bonding was not reliably achieved with inertia welding. The deficiency points out the need for development of nondestructive testing techniques for this type of joint. Additionally, solid-state volume diffusion did not appear to be a satisfactory explanation for the inertia and friction-welding bonding mechanism.

3321 **In situ preparation of thin sodium films as an expendable filter in the vacuum ultraviolet.** Ederer, D.L.; Callcott, T.A.; Arakawa, E.T. (Synchrotron Ultraviolet Radiation Facility, National Bureau of Standards, Washington, D.C. 20234). *Rev. Sci. Instrum.;* **50**: No. 12, 1618-1621(Dec 1979).

The use of a sodium film as a filter for wavelengths between 40 and 80 nm is discussed, and a technique to prepare these films is described. Sodium films of 230 nm thickness were demonstrated to have a transmission of 55% at 100° K at a wavelength 41 nm. The transmission decreased to 40% after 18 h in a vacuum of 5×10^{-8} Torr. Films of this thickness were shown to attenuate 20.5-nm radiation appearing in second order at 41 nm by at least a factor of 50.

3322 **Preparation of zirconium alloys containing transition metal elements.** Tanner, L.E.; Ray, R. (to Allied Chemical Corp.). US Patent 4,171,992. 23 Oct 1979. Filed date 3 Apr 1978. 6p.

Zirconium alloys containing at least two of the transition metal elements of iron, cobalt, and nickel are disclosed. The alloys consist essentially of at least two elements selected from the group consisting of about 1 to 27 atom percent iron, about 1 to 43 atom percent cobalt and about 1 to 42 atom percent nickel, balance essentially zirconium plus incidental impurities. The alloys in polycrystalline form are capable of being melted and rapidly quenched to the glassy state. Substantially totally glassy alloys of the invention evidence unusually high resistivities of over 200 μΩ-cm.

3323 **1979 Adams lecture: the technology of brazing and soldering is broad-based and vital to the industrial economy.** Slaughter, G.M. (Oak Ridge National Lab., TN). *Weld. J. (Miami);* **59**: No. 10, 17-28(Oct 1979).

Brazing and soldering processes are essential to the successful production of many of the items or components that are commonplace in industry, in governmental installations, and in our homes. Brazing is vital to the fabrication of components ranging from jet aircraft engines to heat exchangers for automotive air conditioners. A general overview of brazing and soldering technology is given. Some of the more important factors that must be considered in producing reliable brazed and soldered joints are described.

3324 **Single crystal growth by the horizontal levitation zone melting method.** McMasters, O.D.; Holland, G.E.; Gschneider, K.A. Jr. (Ames Lab., IA). *J. Cryst. Growth;* **43**: 577-583(1978).

The method used to prepare large single crystals of some rare earth metals and intermetallic compounds is described. A levitated molten zone is passed along a rod shaped sample which is contained in a cold crucible in the horizontal position. The high frequency power system used to both create and levitate the molten zone is also described. The conditions required to grow crystals larger than one cubic centimeter of both incongruent and congruent melting compounds are given. The quality and some pertinent property values of the crystals as determined by x-ray and metallographic methods are included.

3325 **Holmium-in-gold nuclear orientation thermometer for use from 1°K to 30°mK.** Barclay, J.A. (Los Alamos Scientific Lab., NM); Bingham, D.; Blamey, P.J. *J. Low Temp. Phys.;* **33**: No. 3-4, 343-355(1978).

The new γ-ray anisotropy thermometer which may ultimately be capable of primary thermometry from ≧ 1°K down to 30°mK is reported. The thermometer is a dilute solid solution, ~ 0.1 at.%, of / sup 166m/Ho in gold. Two different sample preparation schemes and other relevant details are discussed. The anisotropy of the 712-keV γ-ray as a function of B and T is presented. The interpretation of the anisotropy in terms of the crystal field, electronic Zeeman, and hyperfine interactions is discussed. It is concluded that incorrect crystal field parameters for HoAu are the reason for the discrepancy between theory and experiment. Relaxation effects are briefly considered.

STRUCTURE AND PHASE STUDIES

REFER ALSO TO CITATION(S) 3324, 3368, 3373

3326 (LBL—9346(Rev.)) **Computer simulation of the martensite transformation in a model two-dimensional body.** Chen, S.; Khachaturyan, A.G.; Morris, J.W. Jr. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jun 1979. Contract W-7405-ENG-48. 8p. (CONF-7906103—1(Rev.)). Dep. NTIS, PC A02/MF A01.

From International conference on martensitic transformation; Boston, MA, USA (24 Jun 1979).

An analytical model of a martensitic transformation in an idealized body is constructed and used to carry out a computer simulation of the transformation in a pseudo-two-dimensional crystal. The reaction is assumed to proceed through the sequential transformation of elementary volumes (elementary martensitic particles, EMP) via the Bain strain. The elastic interaction between these volumes is computed and the transformation path chosen so as to minimize the total free energy. The model transformation shows interesting qualitative correspondencies with the known features of martensitic transformations in typical solids.

3327 **High temperature vaporization and Raoult's-law studies with ^{243}Am metal.** Ward, J.W.; Kleinschmidt, P.D.; Haire, R.G. (Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *J. Chem. Phys.;* **71**: No. 10, 3920-3925(15 Nov 1979).

The vapor pressure of high purity ^{243}Am metal has been measured over the temperature range 1200—1600 K, using combined target and mass spectrometric Knudsen effusion techniques. This work was performed to extend data into the liquid phase, and to compare results with earlier ^{241}Am experiments. Second-law and third-law heats of vaporization are in close agreement with the earlier work, and no isotope effect was found. An additional study of the vaporization of ^{243}Am from a liquid La host was made to explore solubility relationships and activities for systems with similar electronic properties. Lanthanum was found to be a nearly ideal solvent, giving the correct heat of vaporization for Am, and activity coefficients slowly changing with temperature, representative of the effects of a small heat of mixing.

3328 **Structure of zeta Pu-Zr, ideal formula $Pu_{23}Zr$.** Cromer, D.T. (Los Alamos Scientific Lab., NM (USA)). *Acta Crystallogr., Sect. A;* **34**: No. ,) p.177(1 Aug 1978).

3329 **Uniformly moving edge dislocation in an elastic strip.** Moss, W.C.; Hoover, W.G. (Univ. of California, Davis). *Philos. Mag.;* **38**: No. 5, 587-592(1978).

A Fourier-transform technique is presented for obtaining the displacement field of an edge dislocation that is moving in a finite-width strip having clamped boundaries. Known results are reproduced by this technique, and new solutions are obtained, which can be compared with those from atomistic models.

3330 **How effectively can grain boundaries pin flux lines.** Das-Gupta, A. (Oak Ridge National Lab., TN); Koch, C.C.; Kroeger, D.M.; Chou, Y.T. *Adv. Cryog. Eng.;* **24**: 350-357(1978).

To study the mechaniam of grain boundary flux pinning and estimate the elementary pinning force per unit length, f/sub pL/, niobium bicrystals were used as a model system. The principal advantage of bicrystals is they allow a single selected grain boundary to be studied, which eliminates the complications of a statistical summation in evaluating f/sub pL/.

MECHANICAL PROPERTIES

REFER ALSO TO CITATION(S) 2993, 3066, 3319, 3323, 3366, 3370, 3371

3331 (DP-MS—79-18) **Effect of heat treatment on fracture of Type 304L stainless steel in a hydrogen environment.** Caskey, G.R. Jr.; Donovan, J.A. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). 1979. Contract EY-76-C-09-0001. 19p. (CONF-790910—3). Dep. NTIS, PC A02/MF A01.

From Symposium on calculation of phase diagrams and thermochemistry; Milwaukee, WI, USA (17 Sep 1979).

Thermal treatments have a significant effect on the mechanical behavior of Type 304L stainless steel tested in a high-pressure (69 MPa) hydrogen environment. A grain size increase from 10 to 350 μm increased susceptibility to hydrogen damage and accentuated changes in fracture morphology. The Hall-Petch relation for yield strength was the same for tests in both hydrogen and helium environments. Sensitization increased ductility loss in hydrogen but did not change the fracture mode of smooth bar tensile specimens. Variation in quench rate from 0.25 to 50°K/sec had only a minor influence on susceptibility to hydrogen embrittlement. The absence of an abrupt load drop at fracture and change in fracture morphology for tests in high-pressure hydrogen indicate that fracture initiated at or near the surface and rapidly propagated inward.

3332 (DP-MS—79-57) **Hydrogen effects on flow localization and fracture in type 304L stainless steel.** Caskey, G.R. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). 1979. Contract EY-76-C-09-0001. 10p. (CONF-790773—1). Dep. NTIS, PC A02/MF A01.

From Gordon research conference; Andover, NH, USA (9 Jul 1979).

The onset of plastic instability, localization of plastic flow, and fracture in Type 304L austenitic stainless steel are modified by the presence of hydrogen. It is not certain, however, whether the observed changes in behavior are attributable to the direct effect of hydrogen on plastic flow or to the intervention of a hydrogen-induced brittle fracture process. The effects are observed in both smooth bar and single edge notched specimens and are dependent on deformation temperature.

3333 (HEDL-TC—1520) **Data package fracture toughness of welds 61W, 62W, and 63W from second 4T irradiations: 0.5TCT specimen tests.** Williams, J.A.; Carlson, K.W. (Hanford Engineering Development Lab., Richland, WA (USA)). Sep 1979. Contract EY-76-C-14-2170. 77p. Dep. NTIS, PC A05/MF A01.

Fracture toughness determinations were made on irradiated welds 61W, 62W, and 63W from the HSST second 4T irradiations. All fracture specimens were 0.5 in. thick compact specimens. Tests were conducted from upper transition through upper shelf in the range of 75 to 500°F. The data package includes testing and analysis methods, tabulations of fracture toughness data, toughness versus temperature curves, J-R curves, J-R data for each unloading compliance test specimen, calculated and measured physical crack lengths, fracture specimen photographs with descriptive information and strength property curves of each weld material.

3334 (NUREG/CR—0980) **Heavy-Section Steel Technology Program. Quarterly progress report, April-June 1979.** Whitman, G.D.; Bryan, R.H. (Oak Ridge National Lab., TN (USA)). Oct 1979. Contract W-7405-ENG-26. 86p. (ORNL/NUREG/TM—347). Dep. NTIS, PC A05/MF A01.

Research results are presented concerning fracture mechanics analysis and investigations, effect of high temperature primary reactor water on the sub-critical crack growth of reactor vessel steels, irradiated materials, pressure vessels, and thermal shock investigations. (FS)

3335 (NUREG/CR—1042) **Predicted strain in austenitic stainless steels under transient stress.** Hammond, J.P.; Sikka, V.K.; Booker, M.K. (Oak Ridge National Lab., TN (USA)). Nov 1979. Contract W-7405-ENG-26. 43p. (ORNL/NUREG/TM—338). Dep. NTIS, PC A03/MF A01.

Tensile results on austenitic stainless steels were analyzed to develop means for predicting strains at stresses above design levels for reactor regulatory applications. Ten heats of type 316 and 19 heats of type 304 stainless steel in the mill-annealed and reannealed conditions at 24, 93, 204, and 316°C and higher were tested. These tensile data were used to compute expected strains under in-service transient stresses (pressures). The effects of heat-to-heat variations on total strain (to 5%) at discrete stress levels by a rational polynomial equation incorporating three constants associated with the basic features of the true stress-true strain diagram were determined. These constants are directly related to yield strength, this single parameter proved adequate to predict heat-to-heat variations in behavior. By inserting expressions of average yield strength (YSa) and lower bound yield strength [YSa - 1.65 SEE (standard error of estimates)] in the polynomial model, we computed: (1) total maximum strains, ϵ/sub m/ (associated with YSa - 1.65 SEE), and (2) ratios of maximum strain to ϵ/sub m//ϵ/sub a/ (denominator associated with YSa).

3336 (ORNL/BRP—79/5) **Mechanical properties test data for structural materials. Semiannual progress report for period ending July 31, 1979.** DiStefano, J.R. (comp.). (Oak Ridge National Lab., TN (USA)). Oct 1979. Contract W-7405-ENG-26. 351p. AT.

Data are presented concerning mechanical properties of Alloy 718 and SS Types 304 and 308. High temperature structural design data for austenitic stainless steel weldments are given. Mechanical properties of Cr-Mo steel steam generator materials, and transition weldjoint material are presented. Neutron irradiation fatigue crack propagation in SS Type 316 breeder reactor material was studied. Data are recorded for breeder reactor materials including Alloy 718 and Inconel X750, and testing data of SS Type 304 and 316. The effect of sodium on transition joints and corrosion fatigue of Cr-Mo steel are presented. Helium effects and thermal aging studies of HTGR materials and creep and strength of SiO_2 were studied. (FS)

3337 (ORNL/TM—6971) **Fatigue crack propagation in the heat-affected zone of 2-1/4 Cr-1 Mo steel and ERNiCr-3 weldments. Interim report.** Weerasooriya, T. (Oak Ridge National Lab., TN (USA)). Oct 1979. Contract W-7405-ENG-26. 38p. AT.

The fatigue crack growth rate at 510°C was examined in the heat-affected zone (HAZ) of a 2-1/4 Cr-1 Mo steel weldment as a function of frequency and stress intensity factor. The weldment was made of isothermally annealed 2-1/4 Cr-1 Mo steel base metal and ERNiCr-3 weld metal. Fatigue crack growth rate data for thermally aged HAZ material lies between the two scatter bands of data for the base metal and ERNiCr-3 filler metal at 510°C. Prior thermal aging up to 2,000 h at 566°C does not substantially change the fatigue crack growth rate of HAZ material at 510°C.

3338 (PB—291508) **Photoelastic studies of crack propagation and arrest in polymers and 4340 steel. Annual report 15 July 1977-30 September 1978.** Irwin, G.R.; Kobayashi, T.; Fourney, W.L.; Metcalf, J.T.; Dally, J.W. (Maryland Univ., College Park (USA). Dept. of Mechanical Engineering). Dec 1978. Contract NRC-04-76-12. 330p. NTIS PC A15/MF A01.

This report describes the progress made during the fourth year on a research program dealing with the dynamic characterization of fracture.

3339 (UCRL—50057-78) **High-rate testing at elevated temperature. Annual report 1978.** Tatro, C.A.; Scott, R.G.; Taylor, A.R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 6 Aug 1979. Contract W-7405-ENG-48. 18p. Dep. NTIS, PC A02/MF A01.

A modification of the split Hopkinson pressure bar technique was devised that permits performance of tension tests at strain rates exceeding 10^4 per second. The increased strain rate is achieved by using a notched specimen. Tests at 500°C are made possible by rapid heating of the specimen critical section with an argon gas jet heater. Direct strain measurements are achieved by photographing the specimen during deformation with a high-speed framing camera; true strain can be measured directly by this method up to specimen fracture. Load measurements are recorded by conventional means. The design of the split Hopkinson pressure bar torsion testing system was also modified to increase strain rate capability and to achieve 500°C test capability. Tests were performed at room temperature and strain rates in excess of 10^3 per second.

3340 (UCRL—83148) **Computer simulation of ductile fracture.** Wilkins, M.L.; Streit, R.D. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1979. Contract W-7405-ENG-48. 12p. (CONF-791205—8). Dep. NTIS, PC A02/MF A01.

From ASME winter annual meeting; New York, NY, USA (2 Dec 1979).

Finite difference computer simulation programs are capable of very accurate solutions to problems in plasticity with large deformations and rotation. This opens the possibility of developing models of ductile fracture by correlating experiments with equivalent computer simulations. Selected experiments were done to emphasize different aspects of the model. A difficult problem is the establishment of a fracture-size effect. This paper is a study of the strain field around notched tensile specimens of aluminum 6061-T651. A series of geometrically scaled specimens are tested to fracture. The scaled experiments are conducted for different notch radius-to-diameter ratios. The strains at fracture are determined from computer simulations. An estimate is made of the fracture-size effect.

3341 **Significance of relaxation cracks for the integrity of light water reactor pressure vessels.** Canonico, D.A. (Oak Ridge National Lab., TN (USA)). *VGB Kraftwerkstech.;* **59**: No. 4, 336-348(Apr 1979). (In German).

It is fairly certain that there are in service today reactor pressure vessels which contain grain boundary separations in the heat affected zones of their welded joints. In addition it is very likely that that type of grain boundary separation exists more in vessels fabricated from SA 508 cl.2 than in vessels fabricated from SA 533 gr.B.cl.1. This is attributed to the greater tendency of the steel SA 508 cl.2 to relaxation cracking. Where grain boundary separation exist in reactor pressure vessels, they cannot however be traced with the nondestructive testing techniques available today during vessel fabrication or during repeat testing.

3342 **Single test methods for determining J during crack growth.** Burns, S.J.; McMeeking, R.M. (Stanford Univ., CA). *Int. J. Fract.;* **14**: R73-R76(1978).

New results based on an assumption that the behavior of a cracked elastic-plastic body during crack growth can be analyzed in terms of a comparison body which experience no unloading are worked out mathematically.

3343 **Role of electron microscopy in design of strong, tough, economical structural steels.** Thomas, G. (Univ. of California, Berkeley). *Iron Steel Int.;* 451-461(Oct 1973).

The microstructures of martensitic and bainitic steels are classified morphologically as determined by thin foil electron microscopy. Correlation of microstructure and properties leads to suggestions for design of strong, tough, economical martensitic and bainitic steels, based on desirable microstructures. It is shown that

as-quenched (autotempered) experimental, vacuum melted, martensitic Fe/Cr/C and Fe/Mo/C steels can have superior mechanical properties in high carbon steels (C>0.4%).

PHYSICAL PROPERTIES

REFER ALSO TO CITATION(S) 3321, 3330

3344 (CONF-790653—15) **Moessbauer study of metal cations in the chevrel phases.** Stafford, B.; Barnet, C.D.; Kimball, C.W.; Fradin, F.Y. (Argonne National Lab., IL (USA); Northern Illinois Univ., Dekalb (USA)). 1979. Contract W-31-109-ENG-38. 7p. Dep. NTIS, PC A02/MF A01.

From Superconductivity in d- and f-band metals; San Diego, CA, USA (21 Jun 1979).

Moessbauer effect studies at ^{119}Sn and ^{57}Fe sites have been made in $Sn_{1.0}Fe_{0.1}Mo_6S_8$ and $Sn_{1.0}Fe_{0.4}Mo_6S_8$ to examine the Sn- and Fe- motion and electronic states in the high T/sub c/, high H/sub c/$_2$ superconductor $SnMo_6S_8$ with Fe additions. Above 50K the ^{57}Fe spectra are asymmetric doublets with isomer shift and quadrupolar splitting similar to that of the intermediate temperature results in $Fe_{1.0}Mo_6S_8$. At 4.4K the Fe atoms have begun to magnetically order. The Sn atoms are found to occupy two electronically different sites in $Sn_{1.0}Fe_{0.4}Mo_6S_8$.

3345 (COO—4220-3) **Chemical diffusion on solid surfaces. Annual progress report.** Hudson, J.B. (Rensselaer Polytechnic Inst., Troy, NY (USA). Dept. of Materials Engineering). Sep 1979. Contract EG-77-S-02-4220. 6p. Dep. NTIS, PC A02/MF A01.

The kinetics of surface diffusion of hydrogen and nitrogen adatoms on Ni(100) surface were studied. All diffusion measurements were made in the temperature range of 770 and 920°K. (FS)

3346 (LBL—9429) **Determination of electronic states in crystalline semiconductors and metals by angle-resolved photoemission.** Mills, K.A. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Aug 1979. Contract W-7405-ENG-48. 152p. Dep. NTIS, PC A08/MF A01.

Thesis.

An important part of the theoretical description of the solid state is band structure, which relies on the existence of dispersion relations connecting the electronic energy and wavevector in materials with translational symmetry. These relations determine the electronic behavior of such materials. The elaboration of accurate band structures, therefore, is of considerable fundamental and practical importance. Angle-resolved photoemission (ARP) spectroscopy provides the only presently available method for the detailed experimental investigation of band structures. This work is concerned with its application to both semiconducting and metallic single crystals.

3347 **Thermal expansion of solids at high temperatures by the gamma attenuation technique.** Drotning, W.D. (Sandia Laboratories, Albuquerque, New Mexico 87185). *Rev. Sci. Instrum.;* **50**: No. 12, 1567-1570(Dec 1979).

A new technique is described for the measurement of the thermal expansion of isotropic solid materials at high temperatures. The method utilizes gamma attenuation to measure thermal expansion with a noncontacting probe. The experimental apparatus and analytical method are described, and results are presented for aluminum to 900 K and type 303 stainless steel to 1660 K to illustrate the use and precision of the technique. These results agree with published values measured by other techniques, and in the case of the stainless steel alloy, some new results are presented in the temperature range 1400—1660 K.

3348 **Determination of the Pd-Gd exchange constant by neutron diffuse scattering and the Pd polarization in PdGd alloys.** Cable, J.W.; Parra, R.E. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Phys. Rev., B: Condens. Matter;* **20**: No. 7, 2765-2768(1 Oct 1979).

The H and T dependence of the Gd moment in ferromagnetic Pd/sub 0.98/Fe/sub 0.01/Gd/sub 0.01/ was investigated by polarized-neutron diffuse-scattering methods. The observed behavior is consistent with a 7/2 Brillouin dependence with an effective Pd-Gd exchange constant of -0.018 eV. A simple molecular-field model with this exchange constant accounts for the existing 4.2-K magnetization data for paramagnetic PdGd alloys and gives a negative Pd polarization for the ferromagnetic alloys. This suggests that a negative Pd polarization occurs in the spontaneous ferromagnetism of these alloys but that this can be reversed in high magnetic fields.

3349 **Normal spectral emissivity measurements on liquid copper.** Dokko, W.; Bautista, R.G. (Iowa State Univ., Ames, IA). *Metall. Trans., B;* **10B**: No. 3, 450-453(Sep 1979).

The normal spectral emissivity of liquid Cu is reported with precautions taken to minimize errors. These precautions include a high quality blackbody, elimination of the effect of reflected light on the pyrometer, film free surface of liquid Cu, accurate calibration for light absorbed through the optical path, and using the same optical path for the temperature measurements. (FS)

3350 **Advances in surface coating technology. Volume 2. Discussion.** Abington, England; Welding Institute (1979). 35p. (CONF-780248—P2).

From International conference on advances in surface coating technology; London, UK (13 Feb 1978).

Thermal spraying, chemical vapor deposition and sputtering, nondestructive testing and quality control, ion implantation and ion plating, other coating methods and surface treatments are discussed. (FS)

3351 **Itinerant antiferromagnetism of $TiBe_2$.** Matthias, B.T.; Giorgi, A.L.; Struebing, V.O.; Smith, J.L. (Los Alamos Scientific Lab., NM). *J. Phys. (Paris), Lett.;* **39**: L441-L442(15 Nov 1978).

Itinerant electron ferro- or antiferromagnetism in metallic compounds can only be taken for certain, if either of the elements is known ever to have a local moment in its metallic state. Until now, of all known materials only Sc_3In and ZrZn fulfilled this criteria. On the basis of recent theoretical analysis it seemed quite probable that $TiBe_2$ crystallizing in a cubic Laves phase would also be an itinerant magnet. This is verified. (FS)

3352 **Experimental magnetic form factor of platinum metal.** Maglic, R. (Argonne National Lab., IL); Brun, T.O.; Felcher, G.P.; Chang, Y.K.; Ketterson, J.B. *J. Magn. Magn. Mater.;* **9**: 318-322(1978).

The induced magnetic form factor of paramagnetic platinum was measured in an external field of 73 kOe at a temperature of 78 K. The data obtained for the six innermost Bragg reflections show that the spherically average magnetization density is in excellent agreement with that calculated by Watson-Yang, Freeman, and Koelling. The result confirms the reliability of the present day band calculations, as well as assuring that the nontrivial orbital contribution to the form factor (g = 2.61) has been handled properly. The asphericity of the magnetization was more poorly determined, yielding a t/sub 2g/ population of 70 +- 17%, to be compared with a calculated value of 93%. An attempt at a more direct determination of the role of the orbital contribution is described.

3353 **Model for hydrogen diffusion in a metal at low temperatures.** Lee, M.H.; Banerjee, S.; Dekeyser, R. (Univ. of Georgia, Athens). *J. Phys. (Paris);* **39**: No. 8, 424-425(1978).

A model for hydrogen diffusion in a metal at low temperatures is constructed assuming that the motions of hydrogen atoms are hindered. The model takes into account the presently known hydrogen-hydrogen interaction mediated by the metal lattice. The time-dependent autocorrelation function is obtained under the condition of a high-density limit.

CORROSION AND EROSION

REFER ALSO TO CITATION(S) 2416, 2464, 2465, 2654, 2936, 2992, 3528

3354 (NTIS/PS—79/0177) **Hydrogen embrittlement of metals. Volume 2. 1975-January, 1979 (citations from the NTIS data base). Report for 1975-January 1979.** Reed, W.E. (National Technical Information Service, Springfield, VA (USA)). Mar 1979. 217p. NTIS PC N01/MF N01.

Studies on hydrogen embrittlement relating to mechanical properties, irradiation, crystal structure, and corrosion are cited. This compilation also covers testing, hydrogen analysis and diffusion, welding, electroplating, fabrication, and processing with respect to the ductile brittle transition in metals. Reports on nuclear reactor materials, hydrogen storage equipment, and energy related systems are included. (This updated bibliography contains 208 abstracts, 42 of which are new entries to the previous edition.)

3355 (NTIS/PS—79/0180) **Hydrogen embrittlement of metals (citations from the American Petroleum Institute data base). Report for 1971-1978.** Reed, W.E. (National Technical Information Service, Springfield, VA (USA)). Mar 1979. 186p. NTIS PC N01/MF N01.

Research reports on hydrogen embrittlement of ferrous and nonferrous metals are cited. Studies relating to mechanical properties, corrosion, failure, testing, and inhibition are presented. Hydrogen embrittlement is described in pressure vessels, pipes, welds, and steels. Reports on materials used in pipeline, refinery, petrochemical, and energy storage service are included. (Contains 181 abstracts)

3356 (NTIS/PS—79/0208) **Corrosion of stainless steel. Volume 2. 1977-March, 1979 (a bibliography with abstracts). Report for 1977-March 1979.** Reed, W.E. (National Technical Information Service, Springfield, VA (USA)). Mar 1979. 135p. NTIS PC N01/MF N01.

Federally-funded research on stainless steel composition, mechanical properties, structure, and testing in relation to corrosion is cited. The majority of research concerns nuclear reactor materials. In addition, corrosion studies in coal gasification plants, rocket

propellant tanks, underwater cables, batteries, and geothermal systems are included. (This updated bibliography contains 129 abstracts, 55 of which are new entries to the previous edition.)

3357 (RFP—2919) **Corrosion of delta plutonium by synthetic sea water.** Hodges, A.E. III; Haschke, J.M. (Rockwell International Corp., Golden, CO (USA). Rocky Flats Plant). 24 Oct 1979. Contract EY-76-C-04-3533. 14p. Dep. NTIS, PC A02/MF A01.

Tests have been performed to determine the corrosive nature of sea water on delta plutonium at 25°C. Corrosion rates were determined by measuring the time dependence of mass loss at constant pressure and the time dependence of hydrogen evolution in a sealed vessel. Test coupons were completely immersed in a standard solution of synthetic sea water for periods ranging from 1 hour to 144 hours. Weight loss measurements show that delta plutonium corrodes at an average rate of 5.01 mg/(cm^2 hr) while hydrogen is formed at an average rate of 1.6 x 10^{-5} mol/(cm^2 hr). The corrosion process is a hydrolysis reaction that produces hydrated plutonium(IV) oxide and hydrogen. The reaction apparently occurs along the grain boundaries of the metal.

3358 (SAND—78-2222C) **Digital faradaic impedance measurements on corroding copper in acid solutions.** Smyrl, W.H. (Sandia Labs., Albuquerque, NM (USA)). 1979. Contract EY-76-C-04-0789. 32p. (CONF-790574—2). Dep. NTIS, PC A03/MF A01.

From ASTM symposium Progress in electrochemical techniques; San Francisco, CA, USA (20 May 1979).

The faradaic impedance of a rotating copper disk has been investigated in oxygenated acid solutions. The impedance measurement system is based on a digital acquisition and analysis of multiple frequency signals. The frequency range investigated was 0.1 to 500 Hz. In sulfuric acid, the corrosion involves the peroxide intermediate whose transport behavior strongly influences the impedance results. Peroxide is not important in hydrochloric acid, but the transport of cuprous ions determines the impedance behavior. Measurements at frequencies higher than about 400 Hz in sulfuric acid show a strong frequency dispersion of the capacitance due to a nonunifom current distribution.

3359 (UCRL—83411) **Corrosion testing of materials in hot concentrated sulfuric acid.** Krikorian, O.H. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 27 Sep 1979. Contract W-7405-ENG-48. 4p. Dep. NTIS, PC A02/MF A01.

Testing and evaluating materials for a sulfuric acid boiler for use in thermochemical hydrogen cycles that require decomposition of H_2SO_4 are reported. Operating conditions call for boiling of 97 wt % H_2SO_4 at ~ 673°K and 1MPa pressure. We have determined that high silicon content materials can generally tolerate the corrosive conditions that prevail. Materials that appear most suitable at present, especially as heat exchanger materials, are Durichlor-51 and SiC. Preliminary tests on $CrSi_2$-coated Incaloy 800 also show good promise.

3360 **Surface craters induced by displacement cascades in heavy metals.** Jaeger, W.; Merkle, K.L. (Argonne National Lab., IL). pp 378-379 of Ninth international congress on electron microscopy. Vol. 1. Toronto, Ontario; Microscopical Society of Canada (1978).

Results from low dose Bi ion irradiation revealed the existence of small craters where cascades intersect a surface. It is shown that this surface crater strongly depends on cascade energy and cascade energy density. Details of the observed crater contrast are discussed in view of its implications in regard to crater formation mechanisms.

RADIATION EFFECTS

REFER ALSO TO CITATION(S) 3009, 3010, 3011, 3012

3361 (CONF-790979—2) **Phase stability and swelling in the V-series alloys.** Sklad, P.S. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 16p. Dep. NTIS, PC A02/MF A01.

From Annual information meeting; Richland, WA, USA (25 Sep 1979).

The response of the V-series alloys to irradiation to a fluence of 7 x 10^{22} n/cm^2 at 593°C covers a range of behavior from a minimum swelling of 0.6% (V4) to a maximum of 8.1% (V5). The major phases identified in the V series alloys examined after irradiation to 7 x 10^{22} n/cm^2 at 593°C are TiC and laves. Between the fluences of 2 x 10^{22} n/cm^2 and 7 x 10^{22} n/cm^2 the compositions of the precipitates identified do not vary significantly. Results of this investigation indicate that the minimum amount of titanium in solution should be ~ 0.16 wt %. Higher levels of titanium in solution will promote more efficient pinning of the dislocation structure and result in lower swelling. Silicon levels greater than 0.5 wt % promote severe phase instabilities which deplete the matrix of elements which suppress swelling. The irradiation performance of this type alloy depends upon the achievement of a uniform distribution of Ti and a balance of Ti, Si, and C in solution which will encourage precipitation of TiC during service.

3362 (INIS-mf—4903, pp 246-272) **Effect of small solute additions on the radiation damage resistance of aluminium alloys.** Harkness, S.D.; Blewitt, T. (Argonne National Lab., IL (USA)); Allen, C.W. (Notre Dame Univ., IN (USA)). 1978.

From Conference on reactor materials science; Alushta, Ukrainian SSR (29 May 1978).

The resistivity recovery of pure Al, Al-1wt%Cu, Al-3wt %Cu, Al-1wt%Zn and Al-1wt%Mg after fast neutron irradiation at 4.2 K and annealing to 225 K as well as the changes in microstructure of these alloys exposed to Ni ions at 373 K (E=3.25 MeV, D=20 dpa) and electrons (E=200 Kev) at 298 K are studied. It is shown that in Al-1wt%Ag and Al-1wt%Zn alloys under irradiation with Ni ions and electrons void formation is considerably reduced as compared with that in pure aluminium. In Al-Cu alloys under Ni ion irradiation no voids are observed though a fine precipitate is developed. However, electron bombardment and thermal ageing at 373 K does not result in the precipitation process. Differences in resistivity recovery during annealing, intensity of void formation and precipitation are associated with the capability of some additions to form mobile mixed solute self-interstitial dumbbells.

3363 (INIS-mf—4903, pp 160-191) **Irradiation induced embrittlement of austenitic alloys.** Harries, D.R. (UKAEA, Harwell. Atomic Energy Research Establishment). 1978.

From Conference on reactor materials science; Alushta, Ukrainian SSR (29 May 1978).

Neutron radiation effects on the properties of austenitic steels and Ni base alloys are reviewed. It is shown that at irradiation temperatures of < or approximately 0.35 Tsub(m) the microstructure consists of a high density of small vacancy and/or interstitial clusters or dislocation loops. These defects impede dislocation motion and produce significant tensile hardening and loss of ductility but do not affect the fracture mechanism. Voids, dislocation loops and small He bubbles are produced and the precipitation is often modified during irradiation at temperatures in the approximate range 0.35 to O.57 Tsub(m). These structures often result in increases in strength and decreases in ductility. Intergranular failure with reduced ductilities in tensile and creep-rupture tests are observed following irradiation at temperatures T > or approximately 0.57 Tsub(m). This high-temperature irradiation embrittlement is associated with the precipitation of He bubbles at grain boundaries and their growth under the action of an applied tensile stress.

3364 (INIS-mf—4903, pp 44-62) **Effect of radiation conditions and chemical composition on the development of radiation damages in neutron irradiated steels and alloys.** Shcherbak, V.I.; Bykov, V.N.; Dmitriev, V.D.; Porollo, S.I. 1978. (In Russian).

From Conference on reactor materials science; Alushta, Ukrainian SSR (29 May 1978).

Kinetics of void nucleation and growth, dislocation structure and precipitated phases in the neutron irradiated OKh18N9T and OKh16N15M3B steels have been investigated in the dose interval of 1-100 d/a. It is shown that void concentration and total dislocation density in steels change with irradiation doses following the exponential law, the exponent varying considerably with chemical composition of steels and irradiation temperature. Rapid precipitation is shown to occur in the initial stage of irradiation, followed by the particle coalescence at high radiation doses. The relationship is established between precipitate kinetics and radiation temperature. Chemical composition effect is shown to be significant in the lower temperature and irradiation dose ranges.

3365 (INIS-mf—4903, pp 148-159) **Helium accumulation in structural materials under reactor irradiation.** Zaluzhnyi, A.G.; Skorov, D.M.; Storozhuk, O.M.; Dashkovskii, A.I.; Agapova, N.P.; Sokurskii, Yu.N.; Onufriev, V.D.; Afrikanov, I.N.; Cherednichenko-Alchevckii, M.V. 1978. (In Russian).

From Conference on reactor materials science; Alushta, Ukrainian SSR (29 May 1978).

A study of helium accumulation in some steels, alloys and model metals has been carried out under irradiation in reactors. The experimental values of helium concentration in irradiated structural materials have been compared with corresponding data obtained by different analysis techniques for the known (n,α) reaction yield, as a rule, the experimental data being higher than the calculated ones. It is determined that during irradiation of nickel, iron and the OKh16N15-M3B steel in the UTP-2000 reactor by a fluence up to 9.3x10^{19}th.n/cm^2 and OKh16N15M3B steel in the BOR-60 reactor by a fluence up to 6.6x10^{22}n/cm^2 (E >0.1MeV) helium accumulation as a function of the fluence is described by approximately parabolic dependence for nickel and linear dependence for iron and the OKh16N15M3B steel.

3366 (INIS-mf—4903, pp 192-213) **Simulation and study of radiation hardening and high temperature embrittlement of reactor**

materials using particle accelerators. Zelenskii, V.F.; Ozhigov, L.S.; Neklyudov, I.M.; Parkhomenko, A.A. 1978. (In Russian).

From Conference on reactor materials science; Alushta, Ukrainian SSR (29 May 1978).

Beams of charged particles (electrons, protons, α-particles) are used for simulation and studies of radiation hardening and high-temperature embrittlement occuring in nuclear- and fusion reactor materials. It is shown that radiation hardening is retained after irradiation with electrons of above-threshold energy as well as after neutron irradiation up to temperatures corresponding to stage V of annealing the radiation-induced defects. The irradiation by high-energy electrons (E=225 MeV) with addition of bremsstrahlung is equivalent in the effect of radiation hardening to irradiation in the fast reactor BR-5 and is 3 times as effective as that in the WCR reactor VVR-M. Studies of the influence of energy, dose, type of bombarding particles and irradiation temperature on stress-strain properties of nickel and OKh16N15M3B steel allow a conclusion to be drawn that high temperature embrittlement is primarily associated with irradiation-induced helium generation.

3367 (INIS-mf—4950, pp 212-225) **New jump mechanisms for dumbbell and induced migration of point defects by molecular dynamics simulation.** Doan, N.V.; Pontikis, V.; Tenenbaum, A. 1978. (In Russian).

From Conference on reactor materials science; Alushta, Ukrainian SSR (29 May 1978).

The induced migration of the (100) - dumbbell is studied using the molecular dynamics simulation. Two new types of jumps are discovered for the dumbbell: first the jump takes place through an intermediate crowdion configuration (110), then the crowdion is converted into the dumbbell configuration with some other orientation. The threshold energy is found for different knocked-on directions. The dependence of the interstitial jump frequency on the incident electron energy is determined for copper. The induced interstitial migration shows a maximum value, but for an electron energy around 15 Kev. The effect of new jump mechanisms on the effective recombination volume is discussed.

3368 (INIS-mf—4950, pp 296-313) **Dependence of the lattice parameter of radiation-induced voids in metals on the irradiation temperature and rate of radiation defect generation.** Konobeev, Yu.V. 1978. (In Russian).

From Conference on reactor materials science; Alushta, Ukrainian SSR (29 May 1978).

It is assumed that the lattice parameter of vacancy clusters (voids, loops, dislocations), formed under certain irradiation conditions, is determined by the kinetics of decomposition of supersaturated point defect solutions and not by the elastic interaction. On the bases of this assumption proceeding from considerations of dimensions it is shown that the relation of the lattice parameter of clusters to the critical radius at the beginning of vacancy parameter of clusters to the critical radius at the beginning of vacancy cluster generation must be a constant value independent of temperature and dose intensity. As an example of agreement of the proposed mechanism of radiation void ordering with experiment the data on pure molybdenum are given.

3369 (INIS-mf—4950, pp 314-339) **Simulation of neutron damage by ion irradiation.** Brimhall, J.L. 1978.

From Conference on reactor materials science; Alushta, Ukrainian SSR (29 May 1978).

Experimental data are given on the correlation of damage from ion irradiation with that from neutrons. The calculated number of displacements per atom (dpa) is compared for different thickness of the irradiated zone in ion bombarded and neutron irradiated specimens. It was found that the calculated swelling of molybdenum irradiated with 5 Mev Ni^{++} ions did not always agree with that obseved experimentally. The temperature dependence of swelling in ion bombarded and neutron irradiated niobium and molybdenum is given. Irradiation temperature, dose and dose rate are shown too be important parameters which must be considered in simulation experiments.

3370 (INIS-mf—4950, pp 226-249) **Theory of swelling and creep of metals under irradiation.** Bullough, R.; Hayns, M.R.; Wood, M.H. 1978.

From Conference on reactor materials science; Alushta, Ukrainian SSR (29 May 1978).

The important components of the microstructure in reactor component materials are identified and related to the expected response of the material to irradiation damage. In particular the dependence of void swelling and irradiation creep on the presence of atomic or precipitate point defect traps and in the rate of generation of transmutation gas is highlighted. Several calculated results are presented and discussed in relation to the overall problem of using simulation results to assist in the design of suitable alloy materials for the fast reactor core components or the first wall of the fusion reactor.

3371 (INIS-mf—4950, pp 250-263) **Theory of high-temperature creep in materials under irradiation.** Slezov, V.V.; Bereznyak, P.A. 1978. (In Russian).

From Conference on reactor materials science; Alushta, Ukrainian SSR (29 May 1978).

Brief analytical review of the theoretic models which were elaborated in the USSR for description of radiation creep and strain recovery is presented. The possibilities are emphasized that can be achieved by taking into account the size distributions of sinks in a crystal. There are a description of void coalescence under extremely high fluences, a prediction of co-existent vacancy loop and void populations behaviour as well as a calculation of crystal deformation after external load cutting-off. The computation of transient radiation creep is performed taking into consideration the stress induced preferential absorption (SIPA) of point defects at dislocation loops differently oriented relative to the load. The results of calculations are compared with published experimental . data.

3372 (INIS-mf—4950, pp 77-102) **Some actual problems in radiation damage research.** Zelenskii, V.F.; Ivanov, V.E. 1978. (In Russian).

From Conference on reactor materials science; Alushta, Ukrainian SSR (29 May 1978).

A review of engineering problems for power industry is presented involving a problem of radiation stability of reactor materials as well as an analysis of the present status of this problem for fast- and thermal neutron and thermonuclear reactors. Principle physical phenomena responsible for the radiation damage of core reactor materials are considered. The problem of using charged particle accelerators is discussed for the study and the express simulation of irradiation-induced effects in solids. The conclusion has been drawn that the accelerators enable to simulate any phenomena in solids under in - reactor irradiation. Some results in - reactor irradiation. Some results / of the experimental study of these phenomena are given. In the paper, the actual problems in Radiation Damage Research are formulated.

3373 (ORO—3912-101-112) **Computer experiment studies on mechanisms for irradiation induced defect production and annealing processes. Final report.** Beeler, J.R. Jr.; Beeler, M.F. (North Carolina State Univ., Raleigh (USA)). Jun 1979. Contract EY-76-C-05-3912. 885p. Dep. NTIS, PC A99/MF A01.

This research is based on pair potentials used in the Brookhaven work. It extends their use in defect production simulations to the 5 MeV range and characterizes the short term annealing of the primary defect states. Defect properties and interactions are studied. Defect interactions include carbon, helium, and misfit metallic substitutional impurity interactions with vacancy and interstitial defects as well as vacancy-vacancy, interstitial-interstitial and vacancy-interstitial interactions. (FS)

3374 **Effects of neutron irradiation on a superconducting metallic glass.** Kramer, E.A.; Johnson, W.L.; Cline, C. (W.M. Keck Laboratory of Engineering Materials, California Institute of Technology, Pasadena, California 91125). *Appl. Phys. Lett.;* **35**: No. 10, 815-818(15 Nov 1979).

The effects of fast neutron irradiation on a superconducting metallic glass (Mo/sub 0.6/Ru/sub 0.4/)$_{82}$B$_{18}$ have been studied. Following irradiation to a total fluence of 10^{19} n/cm^2, T/sub c/ increases from 6.05 to 6.19 K, and the width of the transition decreases sharply. The density of the material decreases by 1.5%, and the x-ray scattering intensity maxima are broadened. An improvement in the ductility of the samples is observed which together with the other observations suggests the production of defects having atomic scale dimensions and characterized by excess volume.

3375 **Radiation effects in structural materials.** Stiegler, J.O.; Mansur, L.K. (Oak Ridge National Lab., TN). *Annu. Rev. Mater. Sci.;* **9**: 405-454(1979).

When energetic particles impinge on a solid, atoms are displaced from their lattice positions. Single or clustered vacant atomic sites are produced and the displaced atoms come to rest in interstitial configurations. The bombarding particles may also induce nuclear transmutations. The initial disturbance of the material is termed radiation damage. At finite temperatures or under continued irradiation the defects migrate; some annihilate and others cluster, both among themselves and with solute atoms. The resulting microstructural changes in the material are more stable than the initial damage and lead to changes in properties termed radiation effects. In particular, changes in dimensions, composition on a microscale, and mechanical properties may be extreme.

3376 **Laser-induced breakdown in optical materials.** Smith, W.L. (Univ. of California, Livermore). Contract W-7405-ENG-48. *Opt. Eng.;* **17**: No. 5, 489-503(Sep 1978).

With the rising importance of powerful lasers in the scientific and industrial communities, material failure by interaction with intense laser radiation is today also a common event. In this status report we review the understanding of the physical processes that

lead to laser-induced breakdown in bulk materials and on their surfaces. The roles and interplay of various mechanisms, which depend on material properties and the laser light intensity and frequency, are discussed. The experimental basis for electron avalanche behavior at optical frequencies is discussed in detail. Multiproton ionization is briefly described. Tabulations of measured breakdown thresholds for transparent solids (bulk, and surfaces), metal surfaces, liquids, and gases, and of multiphoton absorption coefficients, are presented. Experiments needed for further progress are discussed.

3377 **Effect of cascade energy density on the defect cluster type in heavy-ion-irradiated gold.** Jaeger, W.; Merkle, K.L. (Argonne National Lab., IL). pp 360-361 of Ninth international congress on electron microscopy. Vol. 1. Toronto, Ontario; Microscopical Society of Canada (1978).

Defect production by energetic displacement cascades in gold was studied. Defect cluster type was determined using steroscopic black-white contrast for small defects. The difference in damage structure produced by atomic and molecular ion irradiation are shown.

CERAMICS, CERMETS, AND REFRACTORIES

REFER ALSO TO CITATION(S) 3314

PREPARATION AND FABRICATION

REFER ALSO TO CITATION(S) 2575

3378 (SAN—0113-035-T1) **Evaporation driven liquid sintering. Progress report.** Whelan, J.M. (Department of Energy, San Francisco, CA (USA). San Francisco Operations Office). Aug 1979. Contract EY-76-S-03-0113-035. 13p. Dep. NTIS, PC A02/MF A01.

Research is reported concerning MgO wetting by LiF; solubility of MgO in LiF, permeation annealing; effects of LiF grain size, temperature, and external LiF sources; plasticity changes; evaporation driven liquid sintering; and apparatus status of SiC-Si. (FS)

STRUCTURE AND PHASE STUDIES

REFER ALSO TO CITATION(S) 3231

3379 (LBL—9802) **Microstructure, defects, and sodium transport in sodium beta-alumina solid electrolytes.** De Jonghe, L.C. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Sep 1979. Contract W-7405-ENG-48. 17p. (CONF-791073—1). Dep. NTIS, PC A02/MF A01.

From US/Japan joint seminar on defects and diffusion in solids; Honolulu, HI, USA (10 Oct 1979).

Some imperfections are discussed, including point defects, non-stoichiometry due to Na_2 0 loss, planar defects and grain boundaries. Their relationship to fast ion transport is indicated. For most cases studied to date, only qualitative relationships between defects and ionic conductivity can be given.

3380 **Selection rules for the spinel-block modes of β and β''-alumina type structures.** Bates, J.B.; Frech, R. (Oak Ridge National Lab., TN). *Chem. Phys. Lett.;* **60**: No. 1, 95-96(15 Dec 1978).

Seletion rules for the k = 0 modes due to vibrations of atoms in the spinel blocks of β- and β''-alumina type structures have been derived. Based on an approximation of an isolated spinel block in β-alumina, it is found that the irreducible representations for the zone center spinel block modes in both cases are identical.

MECHANICAL PROPERTIES

REFER ALSO TO CITATION(S) 2979, 3336

3381 (HEDL-SA—1813) **Primary creep of UO_2 above 2000°C.** Slagle, O.D. (Hanford Engineering Development Lab., Richland, WA (USA)). 28 Aug 1979. Contract EY-76-C-14-2170. 23p. (CONF-791045—2). Dep. NTIS, PC A02/MF A01.

From American Ceramic Society conference; New Orleans, LA, USA (14 Oct 1979).

A technique for measuring primary creep was developed which facilitates rapid load application to high temperature creep samples. Creep strain measurements for times as short as one second can be made. The strain as a function of time has a logarithmic relationship with a time exponent of 0.7 +- 0.1. Although the resulting expression is in conflict with the normal way of describing the high temperature deformation of fuel under stress, it is possible to incorporate so-called steady state creep into the proposed primary creep relationship. (FS)

3382 (HEDL-SA—1858) **Thermal ramp rate effects on mixed-oxide fuel swelling/gas release.** Hinman, C.A.; Randklev, E.H. (Hanford Engineering Development Lab., Richland, WA (USA)). 21 May 1979. Contract EY-76-C-14-2170. 19p. (CONF-791045—3). Dep. NTIS, PC A02/MF A01.

From American Ceramic Society conference; New Orleans, LA, USA (14 Oct 1979).

Macroscopic swelling behavior of PNL-10 was compared to that of PNL-2 fuel and it was found that the swelling-threshold behavior is similar for similar thermal conditions. Transient fission gas release for the PNL-10 fuel is very similar to that observed for the PNL-2 fuel for similar thermal conditions. (FS)

PHYSICAL PROPERTIES

REFER ALSO TO CITATION(S) 3075, 3231, 3233, 3234, 3235

3383 (CONF-790738—4) **Moessbauer effect investigations of the electronic and magnetic properties of rare earth metal and intermetallic hydrides.** Dunlap, B.D.; Shenoy, G.K.; Friedt, J.M.; Viccaro, P.J.; Niarchos, D.; Kierstead, H.; Aldred, A.T.; Westlake, D.G. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 17p. Dep. NTIS, PC A02/MF A01.

From Joint INTERMAG-MMM conference; New York, NY, USA (17 Jul 1979).

Moessbauer spectroscopy has been used in a number of investigations of elemental rare earth (RE) metal and RE - transition metal intermetallic hydrides. Analysis of hyperfine parameters has established the crystalline electric field (CEF) ground state for Dy^{3+} in DyH_2 and for Er^{3+} in ErH_2 and YH_2. In all cases the results are compatible with the presence of negatively charged hydrogen atoms. Long range magnetic ordering is observed in the RE-H_2 compounds. In DyH_2, short-range magnetic ordering is seen at temperatures up to twice the long-range transition temperature. This arises from the changes in CEF symmetry due to the presence of a few H atoms which are not in regular tetrahedral sites. These effects are much more pronounced in slightly non-stochiometric compounds and can result in dramatic changes in the magnetic ordering temperature. As an example of an intermetallic hydride, we have studied the cubic Laves phase RE-iron compounds. These form several stable hydride phases RE-Fe$_2$H/sub x/, with the maximum x being in excess of 4. The magnetic transition temperatures decrease to roughly half their original values for x=3.5, and the RE-Fe exchange interaction is weakened. For x=4, by a sharp reduction in both the Fe magnetic moment and the magnetic ordering temperature occurs.

3384 (CONF-790862—2) **Low temperature thermal conductivity of $KTaO_3$ and KTN single crystals.** de Gooer, A.M.; Salce, B.; Boatner, L.A. (CEA Centre d'Etudes Nucleaires de Grenoble, 38 (France). Service des Basses Temperatures; Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 3p. Dep. NTIS, PC A02/MF A01.

From 3. international conference on phonon scattering in condensed matter; Providence, RI, USA (28 Aug 1979).

Thermal conductivity of three $KTaO_3$ mixed crystals containing different impurities was measured. Specific heat data show large discrepancies with the calculated Debye contribution so the question of the existence of a phase transition below 10°K remains open. (FS)

3385 (COO—2390-T1) **Basic research in crystalline and non-crystalline ceramic systems. Annual report, August 1, 1978-October 31, 1979.** (Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Materials Science and Engineering). 1979. Contract EY-76-S-02-2390. 83p. Dep. NTIS, PC A05/MF A01.

Research is reported in optical and dielectric properties of MgO, aluminium oxide, and y-doped UO_2; kinetic studies of MgO, magnesium hydroxide, KCl-doped $SrCl_2$, KCl, and Al_2O_3; defect structures of MgO, ZnO-Bi_2O_3, SiC, Sc_2O_3, Al_2O_3, Cr_2O_3, and SiO_2; sintering studies of alumina; and mechanical properties of UO_2, Al_2O_3, and creep in W. (FS)

3386 (LA-UR—79-1112) **Boron carbide-carbon composites and composites for cryogenic applications.** Sheinberg, H. (Los Alamos Scientific Lab., NM (USA)). 1979. Contract W-7405-ENG-36. 24p. (CONF-791036—1). Dep. NTIS, PC A02/MF A01.

From 5. conference of powder metallurgy; Poznan, Poland (3 Oct 1979).

Because of its neutronic properties, high hardness, and high melting temperature, boron carbide (B_4C) is widely used at the Los Alamos Scientific Laboratory. However because of its hardness and mode of manufacture, it is expensive to machine finish to tight dimensional specifictions. For some neutronic applications, a density considerably below the theoretical 2.52 Mg/m^3 was acceptable, and this relaxation in density specification permitted addition of carbon as a second phase to reduce machining costs. We conducted an experimental program to prepare 50.8-mm-diam by 34.8-mm-thick cylinders of B_4C and B_4C-C composites with concentrations of carbon varying from 5.5 to 30 volume percent. Additionally we used

three forms of carbon, natural flake graphite, synthetic graphite flour, and a fine furnace black as the source of the second phase. We determined the sound velocity, compressive strength, coefficient of thermal expansion, electrical resistivity, and microstructure as functions of composition. Additionally, an enriched boron (^{10}B)-carbon composite was studied as an alternate material.

3387 (UCID—18277) **Status of SiO_2/TiO_2 HR coating damage.** Lowermilk, W.H. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 13 Sep 1979. Contract W-7405-ENG-48. 11p. Dep. NTIS, PC A02/MF A01.

The data, observations, and conclusions from a number of experiments on high-reflector (HR) coating damage which were done in FY 1979 are summarized. Damage threshold measurements for the experiments described are presented.

3388 **Superconductivity ot ternary rare-earth Compounds. III. An analysis of experimental data on the rhodium boride system.** Youngner, D.; Machida, K. (Ames Laboratory—USDOE and Department of Physics, Iowa State University, Ames, Iowa). *J. Low Temp. Phys.;* **36**: No. 5, 617-636(1 Sep 1979).

In earlier papers by the same authors a theory which discussed the effects ferromagnetic spin fluctuations on superconductivity was presented. In this paper it is shown that experimental measurements of the phase diagrams and upper critical fields of several pseudo-ternary rare-earth rhodium boride compounds can be explained using the theory. The rare-earth atoms behave magnetically like free 3^+ ions, and couple weakly to the conduction electrons with a strength that is nearly independent of their atomic number. The rare-earth compounds are typically quite dirty and have very short spin-orbit scattering times. It is predicted that the jump in specific heat in most of these compounds will exceed the BCS value.

CORROSION AND EROSION

REFER ALSO TO CITATION(S) 2655, 3233, 3558

3389 (DOE/NASA/2593—79/9) **Reactions of calcium orthosilicate and barium zirconate with oxides and sulfates of various elements.** Zaplatynsky, I. (National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center). Oct 1979. Contract EF-77-A-01-2593. 17p. (NASA-TM—79272). Dep. NTIS, PC A02/MF A01.

Calcium orthosilicate and barium zirconate were evaluated as the insulating layer of thermal barrier coatings for air-cooled gas turbine components. Surface temperatures of such coatings might reach 1300 to 1400°C in hot spot locations. Thus chemical stability of these compounds was studied at 1100 and 1300°C in the presence of some oxides and sulfates for times to 400 and 200 hours respectively. The oxides and sulfates studied represent some of the oxidation products of impurities found in the combustion air, or the fuels as well as the elements in the bond coat alloys. These compounds are listed below, according to their reactivity with calcium orthosilicate (actual composition was 1.78 $CaO.SiO_2$) and barium zirconate. When comparing these results with data available for reactions between similar compounds and ZrO_2-8w/oY_2O_3, it can be noted that all three materials reacted with SiO_2, P_2O_5, and V_2O_5. Also, zirconia was susceptible to attack by alkali and alkaline earth metal oxides. Calcium orthosilicate and barium zirconate were not susceptible to such attack but reacted readily with Al_2O_3 and Cr_2O_3, which did not react with ZrO_2-8w/oY_2O_3.

RADIATION EFFECTS

REFER ALSO TO CITATION(S) 3376

COMPOSITE MATERIALS

PREPARATION AND FABRICATION

3390 (CONS—3205-T2) **Development of a low loss magnetic composite utilizing amorphous metal flake. Second semi-annual progress report, March 19-September 18, 1979.** (General Electric Co., Schenectady, NY (USA). Metallurgy Lab.). Oct 1979. Contract ET-78-C-01-3205. 60p. Dep. NTIS, PC A04/MF A01.

Composite specimens of amorphous metal flakes have been made using several different binders and several different compaction parameters. The binders have included epoxies, anaerobic adhesives, polyimides, polyamideimides, polyeherimides, and polyesterimides. Compaction variables included the time, temperature and pressure of compaction; flake size, and flake alignment. The best results were achieved using a polyetherimide and aligned flake. Packing factors of 87% were achieved in specimens which also exhibited high mechanical integrity and the ability to withstand a high temperature anneal.

MECHANICAL PROPERTIES

REFER ALSO TO CITATION(S) 3390

3391 (GA-A—15508) **Examination of compression and resilience characteristics of fibrous insulation blankets.** Brislin, R.J.; Middleton, A. (General Atomic Co., San Diego, CA (USA)). Aug 1979. Contract AT03-76ET35300. 22p. (CONF-791067—1). Dep. NTIS, PC A02/MF A01.

From 32. Pacific Coast regional meeting of the American Ceramic Society; Seattle, WA, USA (24 Oct 1979).

Load-deflection characteristics of alumina and alumino-silicate fibrous blankets were experimentally determined. Load retention and springback capability of combinations of these materials were measured in a 10,000-hour test at surface temperatures of 650 to 1000°C (1200 to 1832°F). Experimental results are presented and future testing plans are discussed.

CORROSION, EROSION, AND DEGRADATION

REFER ALSO TO CITATION(S) 3488

3392 **Epidermal carcinogenicity of bis(2,3-epoxycyclopentyl)ether, 2,2-bis(p-glycidyloxyphenyl)propane, and m-phenylenediamine in male and female C3H and C57BL/6 mice.** Holland, J.M.; Gosslee, D.G.; Williams, N.J. (Oak Ridge National Lab., TN). *Cancer Res.;* **39**: 1718-1725(May 1979).

The systemic toxicity and skin carcinogenicity of bis(2,3-epoxycyclopentyl)ether, 2,2-bis(p-glycidyloxyphenyl)propane, and m-methylenediamine were assesses relative to benzo(a)pyrene by application to the skin of male and female C3H and C57BL/6 mice three times/week for 24 months. The bis(2,3-epoxycyclopentyl)ether and the 2,2-bis(p-glycidyloxyphenyl)propane were also applied as an equal parts mixture to determine whether the materials would interact as skin carcinogens. A comparison of dose responses showed that benzo(a)pyrene was 107×10^3, 161×10^3, and 51×10^3 more potent as a skin carcinogen than was bis(2,3-epoxycyclopentyl)ether, 2,2-bis(p-glycidyloxyphenyl)propane, and their mixture, respectively. The m-phenylenediamine was not carcinogenic in skin of either strain at the maximum exposure rate allowed by systemic toxicity. The two inbred strains used in these studies exhibited a constant ratio of sensitiity to induction of epidermal cancer by diverse chemical agents. Statistical analysis of this difference for various compounds at different dose rates revealed that C57BL/6 mice were 2.4 times more sensitive to epidermal carcinogenesis than were C3H mice under identical circumstances of exposure. It is suggested that when carcinogenicity is assessed on a relative basis, the observed constancy in the ratio of response would enable these two inbred strains to be used interchangeably. The choice of strain would affect significantly the sensitivity of the assay, but this would become important only in the assay of extremely weak carcinogens.

RADIATION EFFECTS

3393 (SAND—79-1208) **Electron-beam induced absorption and hardening in fiber-optic waveguides to 1060 nm laser pulses.** Landry, M.J.; Davis, H.P. (Sandia Labs., Albuquerque, NM (USA)). Jul 1979. Contract EY-76-C-04-0789. 26p. Dep. NTIS, PC A03/MF A01.

The coupling efficiencies (output/input energy) before and after electron-beam irradiation, the output energy density, the induced attenuation or loss (L/sub I/) and its decrease as a function of time, and hardening as a function of number of Febetron shots (N/sub F/) were determined for fiber-optic waveguides (FOWs). The FOWs were electron-beam irradiated with 8.3 to 12.3 J/cm^2 for 2.36 to 2.84×10^6 R (^{60}Co equivalent) dose. The output laser energy density varied from 0.19 to 2.12 kJ/cm^2 which was about 50 percent of the input surface threshold damage level previously measured in similar FOWs. The induced attenuation (L/sub I/) as a function of recovery time (t) (after electron-beam irradiation) was linear on log-log plot for a short time ($< 2.2 \times 10^{-4}$ s), changing from 1.8 to 0.2 in slightly larger than one order of magnitude change in t. The rate of recovery decreased with increasing time so that the total change in L/sub I/ was about 3 orders of magnitude in 6 orders of magnitude change in time. A slight hardening occurred in fibers with increasing number of Febetron shots.

POLYMERS AND PLASTICS

STRUCTURE AND PHASE STUDIES

REFER ALSO TO CITATION(S) 3448

3394 (UCID—18283) **LLL results on round robin analytical testing of polysiloxane gums.** Cady, W.E.; Hoffman, D.M.; Jessop, E.S.; Kolb, J.R. (California Univ., Livermore (USA). Lawrence

Livermore Lab.). 27 Sep 1979. Contract W-7405-ENG-48. 12p. Dep. NTIS, PC A02/MF A01.

Three silicone gums were tested: Rhodia's RG97, General Electric's random SE54, and Union Carbide's Y3976. The items analyzed were molecular weight, vinyl content, phenyl content, SiOH, volatiles, elements (K, P, N) and dynamic viscosity. (DLC)

3395 Influence of the ratio of styrene and acrylonitrile in cross-linked polymeric binders for use in high-temperature polymer concrete composites. Zeldin, A.; Kukacka, L.E.; Carciello, N. (Brookhaven National Lab., Upton, NY). *J. Appl. Polym. Sci.;* **24**: No. 7, 1759-1765(1 Oct 1979).

The feasibility of using a monomer composition based on a styrene-acrylonitrile copolymer as a binder in high-strength and chemically resistant polymer concrete was demonstrated earlier. From this work it is clear that properties of the polymer concrete composite are dependent on the styrene/acrylonitrile ratio. This paper deals with the study of the effect of the styrene/acrylonitrile ratio in styrene-acrylonitrile-acrylamide-trimethylolpropane trimethacrylate monomer formulations on the thermomechanical properties of polymer concrete composites. 6 figures.

MECHANICAL PROPERTIES

REFER ALSO TO CITATION(S) 3338, 3395, 3449

3396 Finite deformation of anisotropic plastic rotating disks. Feng, W.W. (Univ. of California, Livermore). *AIAA J.;* **16**: No. 11, 1205-1207(Nov 1978).

Equations to solve the nonlinear problem of rotating disks are solved. The rotating disks exhibit anisotropic properties in planes other than their own. Material properties in the rotating plane are assumed to be isotropic: therefore the axisymmetric rotating disk before deformation remains axisymmetric after deformation. (FS)

PHYSICAL PROPERTIES

REFER ALSO TO CITATION(S) 2773

3397 (SAND—79-1477C) **Thermopower and transport properties of AsF_5 doped polyacetylene.** Kwak, J.F.; Gill, W.D.; Greene, R.L.; Seeger, K.; Clarke, T.C.; Street, G.B. (IBM Research Div., San Jose, CA (USA)). 1979. Contract EY-76-C-04-0789. 35p. (CONF-790395—1). Dep. NTIS, PC A03/MF A01.

From Symposium on structure and properties of highly conducting polymers and graphite; San Jose, CA, USA (29 Mar 1979).

Measurements of the thermoelectric power versus temperature of (CH)/sub x/ doped with various concentrations of AsF_5 are reported. These reflect the semiconductor-metal transition at ~ 1% doping. The pristine thermopower is consistent with the conductivity-derived activation energy of 0.35 eV, and a residual defect/impurity carrier concentration of 0.1%. An analysis of the conductivity based on these data indicates that, while the disorder is certainly important, it is not the cause of the transition.

3398 Polishing of glass microbubbles. Ulrich, A.R.; Souers, P.C. (Univ. of California, Livermore). *J. Phys., E (London);* **11**: 888-889(1978).

A method for polishing glass microbubbles into hemispheres is described.

OTHER MATERIALS

PREPARATION AND MANUFACTURE

REFER ALSO TO CITATION(S) 2627, 2761, 2772

STRUCTURE AND PHASE STUDIES

REFER ALSO TO CITATION(S) 3411, 3850

3399 (CONF-790641—11) **Absorption spectrophotometric and x-ray diffraction studies of NdI_3, NdOI, and SmI_3.** Haire, R.G.; Young, J.P.; Bourges, J.Y. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 6p. Dep. NTIS, PC A02/MF A01.

From Rare earth research conference; Fargo, ND, USA (25 Jun 1979).

Results are described of the examination of anhydrous triiodides of neodymium and samarium and the oxy-iodide of neodymium, by x-ray powder diffraction and spectrophotometry. Lattice parameters are given LaI_3, PrI_3, NdI_3, SmI_3, GdI_3, TbI_3, and NdOI. (FS)

3400 Surface-induced ordering of a liquid crystal in the isotropic phase. Miyano, K. (Argonne National Laboratory, Argonne, Illinois 60439). *J. Chem. Phys.;* **71**: No. 10, 4108-4111(15 Nov 1979).

A detailed account of a measurement of order parameter of a liquid crystal at the boundary by means of the wall-induced pretransitional birefringence is given. Several surface treatments were studied including surfactants and evaporated films. Although all treatments produced good alignment in the nematic phase, the boundary order parameter (hence the strength of the aligning force) in the isotropic phase differed very much depending on the treatment, indicating the diverse nature of the alignment process.

PROPERTIES

REFER ALSO TO CITATION(S) 2430, 2915, 3346, 3378, 3558

3401 Optical studies of liquid formamide in the vacuum ultraviolet. Heller, J.M. Jr.; Hubbell, H.H. Jr.; Painter, L.R.; Birkhoff, R.D. (Physics Department, University of Tennessee, Knoxville, Tennessee 37916). *J. Chem. Phys.;* **71**: No. 11, 4641-4645(1 Dec 1979).

Optical and dielectric functions of liquid formamide have been measured between 2 and 24.5 eV. Below 7.8 eV a semicylinder technique was used, whereas above 10.4 eV a new ionization method was employed. Peaks in the absorption spectrum at approximately 6.8 and 16.0 eV are attributed to excitation of π and σ electrons in the formamide molecule. The latter electrons participate in a collective oscillation as evidenced by a shift in the peak in the energy loss function from the corresponding peak in the absorption spectrum. Sum rule calculations give 11.8 and 4.3 of the eighteen formamide valence electrons participating in optical absorption and energy loss processes, respectively, out to 24.5 eV.

3402 Variable angle photoelectron spectroscopy of the fluoroethylenes. Sell, J.A.; Kuppermann, A. (Arthur Amos Noyes Laboratory of Chemical Physics, California Institute of Technology, Pasadena, California 91125). *J. Chem. Phys.;* **71**: No. 11, 4703-4715(1 Dec 1979).

He I photoelectron spectra of fluoroethylene, 1,1-difluoroethylene, cis-1,2-difluoroethylene, trans-1,2-difluoroethylene, trifluoroethylene, and perfluoroethylene were obtained over the scattering angle range of 45° to 120° and compared with those of ethylene. Vibrational frequencies of the ionic states were measured and their symmetry modes assigned. The asymmetry parameter β as a function of the ionization potential was measured for each molecule. The value of β for the first ionization potential band of these molecules was found to decrease monotonically with increasing fluorine substitution. This variation was interpreted as being due to resonance mixing of the lone pair F π orbitals with C—C π orbitals. The data obtained were used to assign some of the spectral bands observed.

3403 Thermodynamics of the lanthanide trifluorides. III. The heat capacity of neodymium trifluoride, NdF_3, from 5 to 350 °K. Lyon, W.G.; Osborne, D.W.; Flotow, H.E. (Chemistry Division, Argonne National Laboratory, Argonne, Illinois 60439). *J. Chem. Phys.;* **71**: No. 10, 4123-4127(15 Nov 1979).

The heat capacity of a well-characterized sample of NdF_3 was measured by aneroid adiabatic calorimetry from 5 to 350 °K. The following results were determined at 298.15 °K: the heat capacity, C/sub p/= (92.42 +- 0.09) J °K^{-1} $mole^{-1}$; the entropy, S^0= (120.79 +- 0.12) J °K^{-1} $mole^{-1}$; the enthalpy increment, [H °(298.15 °K)-H° (0)]=17 360 +- 17 J $mole^{-1}$; and the Planck function, -[G° (298.15° K)-H ° (0)]/T= (62.56 +- 0.06) J °K^{-1} $mole^{-1}$. The values of the last three functions were adjusted for the removal of the degeneracy associated with the ground-state Kramer's doublet of Nd^{+3}. A table of recommended thermal functions of NdF_3 from 400 to the melting temperature, 1650 °K is presented. The excess heat capacity due to the internal electronic energy levels of Nd^{+3} was calculated from spectroscopic data and also from calorimetric results and the two calculations were found to be in reasonable agreement.

3404 Shock-wave compression of lithium niobate from 2.4 to 44 GPa. Stanton, P.L.; Graham, R.A. (Sandia Laboratories, Albuquerque, New Mexico 87185). *J. Appl. Phys.;* **50**: No. 11, 6892-6901(Nov 1979).

Shock compression of lithium niobate above the Hugoniot elastic limit (about 2.5 GPa) reveals a succession of unusual features. Just above the Hugoniot elastic limit, the shock velocity is observed to be well below the bulk sound speed, indicative of a drastic reduction of shear strength. The shock velocity is observed to increase with particle velocity at an unusually large rate due to the reduction of strength in a very stiff material and an anomalously large pressure derivative of the bulk modulus. This later behavior may be due to the effects of localized shock heating resulting from heterogeneous shear deformation in ferroelectrics like lithium niobate and lithium tantalate in which increases in temperature are shown to have a strong effect on bulk modulus. A shock-induced polymorphic phase transition occurs at 13.9 GPa. Above the transition point the slope of the Hugoniot curve relating shock velocity and particle velocity is unusually low, indicative of a broad mixed phase region of undetermined extent. Limited work is reported on the isomorphous crystal, lithium tantalate, which exhibits features

similar to lithium niobate with a Hugoniot elastic limit of 4 GPa and a phase transition in the vicinity of 19 GPa.

3405 Low-temperature helium release in nickel. Thomas, G.J.; Swansiger, W.A.; Baskes, M.I. (Sandia Laboratories, Livermore, California 94550). *J. Appl. Phys.;* **50**: No. 11, 6942-6947(Nov 1979).

Measurements of ^{3}He released by thermal desorption have been made in high-purity annealed, cold-worked, and single-crystal nickel samples. The ^{3}He was introduced by natural tritium decay to eliminate implantation produced defects. Release was observed in the temperature region from ~100 to 300 K and above 800 K; no desorption occurred at intermediate temperatures. The low-temperature release amounted to only ~1% of the total ^{3}He generated. Thus, even in the case of relatively defect-free materials, helium becomes strongly trapped with a binding energy of ~2 eV. The low-temperature data can best be modeled with a bulk mobility of ~0.35 eV and a pipe diffusion path of lower activation energy.

3406 One-dimensional ordering in ferroelectric CsD_2PO_4 and CsH_2PO_4 as studied with neutron scattering. Frazer, B.C.; Semmingsen, D.; Ellenson, W.D.; Shirane, G. (Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev., B: Condens. Matter;* **20**: No. 7, 2745-2754(1 Oct 1979).

The triple-axis neutron technique has been used in a detailed study of the intensity distribution and temperature dependence of the diffuse quasielastic scattering associated with the ferroelectric transitions in monoclinic CsD_2PO_4 and CsH_2PO_4. The diffuse scattering differs greatly from that observed previously in tetragonal KD_2PO_4, in which case the intensity distribution clearly exhibits characteristics of three-dimensional dipolar interactions. In the present study, the nature and extent of the diffuse scattering can be explained quantitatively on the basis of chainlike ordering with temperature-dependent interchain correlations. The variation in intensity measured perpendicular to the chains (which are parallel to the ferroelectric b axis) is mostly due to variations in the dynamical structure factor of a hydrogen-bonded chain of phosphate groups, and approaches a purely-one-dimensional form at temperatures well above T/sub c/. The width of the scattering along the chain direction has been measured accurately for CsD_2PO_4 and yields an intrachain correlation of about 600 A near T/sub c/ (264 K), decreasing to about 140 A at 315 K. Near T/sub c/, the cross section develops short-range three-dimensional interchain correlations with no appreciable change in linewidth. Very near T/sub c/, the range of the latter is only about 30 A.

3407 Reduced nuclear magnetic relaxation by paramagnetic impurities in one dimension. Richards, P.M. (Sandia Laboratories, Albuquerque, New Mexico 87185). *Phys. Rev., B: Condens. Matter;* **20**: No. 7, 2964-2970(1 Oct 1979).

The paramagnetic-impurity contribution to NMR relaxation of a diffusing nucleus is shown to be proportional to c^2 in one dimension as opposed to c in three dimensions, where c is the impurity concentration. The mechanism is thus not expected to be important for one-dimensional superionic conductors except at high doping levels, whereas it is significant even in nominally "pure" three-dimensional superionics. This brings into question the interpretation of recent NMR results in supposedly one-dimensional β eucryptite as being due to paramagnetic impurities.

3408 Molecular theory of orientational fluctuations and optical Kerr effect in the isotropic phase of a liquid crystal. Flytzanis, C.; Shen, Y.R. (Centre National de la Recherche Scientifique, Orsay, France). *Phys. Rev. Lett.;* **33**: No. 1, 14-17(1 Jul 1974).

By use of Kubo's statistical formalism, the orientational fluctuations of interacting molecules are shown to be responsible for both the narrow central component and the broad Rayleigh-wing component in the light-scattering spectrum of a liquid crystalline material. The same formalism also describes the optical Kerr effect. The difference between the microscopic and the macrosopic order parameters are pointed out.

RADIATION EFFECTS

REFER ALSO TO CITATION(S) 3376

3409 Pulsed electron beam induced recrystallization and damage in GaAs. Tandon, J.L.; Golecki, I.; Nicolet, M.; Sadana, D.K.; Washburn, J. (Rockwell International Electronics Research Center, Thousand Oaks, California 91360). *Appl. Phys. Lett.;* **35**: No. 11, 867-869(1 Dec 1979).

Single-pulse electron-beam irradiations of 300-keV 10^{15} Kr^+/cm^2 or 300-keV 3×10^{12} Se^+/cm^2 implanted layers in unencapsulated <100> GaAs are studied as a function of the electron beam fluence. The electron beam pulse had a mean electron energy of ≃20 keV and a time duration of ≃10^{-7} s. Analyses by means of MeV He^+ channeling and TEM show the existence of narrow fluence window (0.4—0.7 J/cm^2) within which amorphous layers can be sucessfully recrystallized, presumably in the liquid phase regime. Too high a fluence produces extensive deep damage and loss of As.

3410 Control of dihydride bond density in reactive sputtered amorphous silicon. Jeffrey, F.R.; Shanks, H.R.; Danielson, G.C. (Ames Laboratory: USDOE and Department of Physics, Iowa State University, Ames, Iowa 50011). *J. Appl. Phys.;* **50**: No. 11, 7034-7038(Nov 1979).

Data are presented which demonstrate how the dihydride bonding density in hydrogenated amorphous silicon produced by reactive rf sputtering may be controlled through variation of the rf sputtering power. It is suggested that as the power is increased, the temperature of the ions and neutral atoms above the substrate surface increases until particles incident on the surface have enough energy to prevent or destroy the dihydride bonding configuration. Conductivity data are also presented which show a decrease in dark conductivity and photoconductivity as dihydride bond density is increased. It is concluded that the dihydride bonding reduces carrier mobility.

3411 Vacancies and the chemical trapping of hydrogen in silicon. Stein, H.J. (Sandia Laboratories, Albuquerque, New Mexico 87185). *Phys. Rev. Lett.;* **43**: No. 14, 1030-1033(1 Oct 1979).

The first evidence for SiH_1-like centers in crystalline Si (c-Si) is presented from infrared measurements of H (D) implanted at 80 K. In contrast to SiH_1 centers in amorphous Si (a-Si) which are stable to ≃ 700 K, the crystalline band anneals below 300 K with an activation energy and illumination enhancement that are characteristic of the Si vacancy. These results relate specific defects for implanted H in c-Si to previous observations for H in a-Si.

CHEMISTRY

REFER ALSO TO CITATION(S) 3314

ANALYTICAL AND SEPARATIONS CHEMISTRY

REFER ALSO TO CITATION(S) 3313

3412 (HASL—300(Suppl.7)) EML Procedures Manual. Harley, J.H. (ed.). (Department of Energy, New York (USA). Environmental Measurements Lab.). 13 Aug 1979. 75p. Dep. NTIS, PC A04/MF A01.

This document comprises additions and corrections to the EML Procedures Manual, HASL-300, which presents analytical methods that are used by the US DOE Environmental Measurements Laboratory. (DLC)

3413 (RDT-F—2-6T(3-79)(Rev.)) Qualification and control of analytical chemistry laboratories for mixed oxide fuel analysis. (Department of Energy, Washington, DC (USA). Office of Nuclear Energy Programs). Mar 1979. Contract W-7405-ENG-26. 30p. RSO.

This standard defines the action required to qualify analytical chemistry laboratories to do the chemical analyses required for the acceptance of fuel material. It also provides a quality control program for the continual evaluation of the analytical data obtained during periods of fuel production.

ACTIVATION AND NUCLEAR REACTION PROCEDURES

REFER ALSO TO CITATION(S) 2577, 3584

CHEMICAL PROCEDURES

REFER ALSO TO CITATION(S) 3665

3414 (BETC/RI—79/10) Potentiometric titration of alkyl aromatic sulfonates using a PVC membrane electrode. Hoke, S.H.; Collins, A.G. (Department of Energy, Bartlesville, OK (USA). Bartlesville Energy Technology Center). Aug 1979. 12p. Dep. NTIS, PC A02/MF A01.

A potentiometric titration method for determinig high-equivalent-weight sulfonates has been developed. This method utilizes a precipitation reaction between sulfonate and quaternary ammonium ions. A PVC (polyvinyl chloride) membrane electrode, which responds to the quaternary ammonium titrant, signals the end point of the titration. Interferences from inorganic and organic anions have been examined. Compared with the visual Methylene Blue Method, this method is faster and of comparable accuracy; it is not sensitive to the color of the sample.

RADIOMETRIC AND RADIOCHEMICAL PROCEDURES

REFER ALSO TO CITATION(S) 2581

3415 (CONF-791049—13) **Carbon-14 in reactor plant water.** Knowles, G.K. (Exxon Nuclear Idaho Co., Inc., Idaho Falls (USA)). 1979. Contract EY-76-C-07-1570. 10p. Dep. NTIS, PC A02/MF A01.

From 23. conference on analytical chemistry in energy technology; Gatlinburg, TN, USA (9 Oct 1979).

The method for the analysis of ^{14}C in reactor plant water and various waste streams previously used at the Idaho National Engineering Laboratory has been shown to be ineffective for samples which contain organic compounds. The previous method consisted of acidification and refluxing of the sample, precipitation of the liberated CO_2, and subsequent analysis by the liquid scintillation method. The method was simple but it did not convert all compounds containing ^{14}C in the sample to CO_2. The new method, while it is based on the previous method, has been improved by employing a strong oxidant, potassium persulfate and silver nitrate, for more complete oxidation of the organics to CO_2. The new method yields ^{14}C values that have typically been one to two orders of magnitude higher than the values obtained using the former method. This indicates that most of the ^{14}C present in the current reactor water samples being analyzed is associated with trace amounts of organics.

SPECTRAL PROCEDURES

REFER ALSO TO CITATION(S) 3433, 3450

3416 (CONF-791049—7) **Mass spectrometric analysis of nanogram levels of ruthenium.** Delmore, J.E. (Exxon Nuclear Idaho Co., Inc., Idaho Falls (USA)). 1979. Contract EY-76-C-07-1570. 6p. Dep. NTIS, PC A02/MF A01.

From 23. conference on analytical chemistry in energy technology; Gatlinburg, TN, USA (9 Oct 1979).

Previous investigations have demonstrated the possibility of using ruthenium originating from the spontaneous fission of ^{238}U for geochronological purposes. Because the abundance of ruthenium is low in geologic specimens and isotopic data are required, an indepth study of the production of steady mass spectrometer ion beams from nanogram amounts of ruthenium was undertaken. The results of this continuing mass spectrometric investigation are presented with some illustrative data.

3417 (LA—7910) **ESCADT: a FORTRAN code for computing the positions and areas of x-ray photoelectron spectral peaks.** Cox, L.E. (Los Alamos Scientific Lab., NM (USA)). Sep 1979. Contract W-7405-ENG-36. 22p. Dep. NTIS, PC A02/MF A01.

Program ESCADT uses least-squares-derived convoluting numbers to smooth and differentiate x-ray photoelectron spectra. Peak maxima are located by finding zero crossings of the first derivative and refined using a cubic polynomial fitting procedure. Background points are located using the product of the absolute value of the first derivative and the smoothed ordinate value. Peak areas, using both linear and scattered electron backgrounds, are computed. Spectra are corrected for changes in instrument sensitivity and energy calibration with gold-standard data retrieved from a disk file. Five determinations of the gold 4f peak positions yielded standard deviations of 0.011 and 0.031 eV for the 4f/sub 7/2/ and 4f/sub 5/2/ peaks, respectively. The relative standard deviation for the computed areas was 0.85%.

3418 **ESR of transient radicals during pyrolysis of fluids.** Livingston, R.; Zeldes, H.; Conradi, M.S. (Oak Ridge National Lab., TN). Contract W-7405-ENG-26. *J. Am. Chem. Soc.;* **101**: No. 15, 4312-4319(18 Jul 1979).

ESR equipment has been developed for directly observing labile free radicals that are present at high temperatures. A pressurized fluid is heated as it slowly flows through the microwave cavity of the spectrometer. Temperatures to 566°C and pressures to 140 kg/cm^2 have been used. Radicals are identified from well-resolved hyperfine structure. Spectra of cyanoisopropyl from the decomposition of azobisisobutyronitrile in solution at 155 to 185°C and hydroxyisopropyl from 2% di-tert-butyl peroxide in isopropyl alcohol at 173 to 258°C are reported. Indenyl is reported from indene in benzene at 533°C and in tetralin at 471°C. 1,2-diphenylethyl has been observed from solutions of 1,2-diphenylethane in benzene from 460 to 560°C. For dilute solutions of 1,2-diphenylethane in toluene the benzyl radical is obtained, while for more concentrated solutions a mixture of radicals is present in the following equilibrium for which K = 10 +- 3 at 560°C and 105 kg/cm^2; $C_6H_5CH_2CH_2C_6H_5 + C_6H_5CH_2 \rightleftharpoons C_6H_5CHCH_2C_6H_5 + C_6H_5CH_3$. Diphenylmethyl is obtained from the dissociation of tetraphenylethane as a dilute solution in benzene and in 50:50 benzene-diphenylmethane. ESR parameters are given in the latter solvent at 420°C. The formation of diphenylmethyl from diphenylmethane as a consequence of impurities has been examined, and diphenylmethane that has been initially air oxidized will form diphenylmethyl upon heating. Cumyl is obtained from cumene at 560°C. α-methylstyrene is a final product but not dicumyl. Dicumyl in benzene solution at 560°C decomposes to give disproportionation products cumene and α-methylstyrene. Hyperfine couplings and g values are given and compared with room temperature values, and a discussion involving kinetic parameters is presented.

3419 **Quantitative comparison of the doubly integrated KLL Auger spectra of magnesium, aluminum, and silicon with their oxides.** Springer, R.W. (Air Force Materials Lab., Wright-Patterson Air Force Base, OH); Haas, T.W.; Grant, J.T. *Am. Soc. Test. Mater., Spec. Tech. Publ.;* No. 643, 64-71(1978).

Integrals, over selected electron energies, E, of magnesium, aluminum, and silicon KLL Auger spectra of magnesium, aluminum, silicon, and their oxides have been measured directly using tailored modulation techniques. The ratios of Auger currents, I(E), measured in this way from the metals and their respective oxides have been determined and are compared with the corresponding atomic densities of magnesium, aluminum, and silicon in the metals and their oxides. It has been found that, if the I(E) are measured over only the quasi-elastic $KL_{2\ 3}L_{2\ 3}$ Auger peaks, the ratios obtained agree quite well with the atomic densities, whereas, if the I(E) are measured over larger energy ranges, thereby encompassing peaks due to plasmon losses, the agreement is rather poor. This poor agreement is probably due to the quite different inelastic loss mechanisms that occur for the metals and their oxides.

SEPARATION PROCEDURES

REFER ALSO TO CITATION(S) 2611

3420 (ORNL/TM—6939) **Sulfur hexafluoride purification from mixtures with air: a process feasibility study.** Perona, J.J.; Watson, J.S. (Oak Ridge National Lab., TN (USA)). Oct 1979. Contract W-7405-ENG-26. 33p. Dep. NTIS, PC A03/MF A01.

Studies were made of the purification of SF_6 vapor contaminated with air for application at the Holifield Heavy-Ion Research Facility. Liquefaction appears to be a good method for recovering about 90% of the SF_6 if it is badly contaminated (15% air), and an even greater fraction can be recovered from mixtures containing less air. In cases where liquefaction is insufficient by itself, adsorption of SF_6 on activated carbon at -50°F is promising. Two carbon beds, each containing about 500 lb of carbon, should be sufficient. The refrigeration system for liquefaction and adsorption would have a capacity of about 2 tons. As an alternative, the use of molecular sieves to trap out the air was investigated, but such a bed would require at least 15,000 lb of molecular sieves and very long cycle times. A large-scale desublimer was also investigated and appears workable, but it would require some development effort before the design could proceed with confidence.

INORGANIC AND PHYSICAL CHEMISTRY

3421 **Photoinduced reaction of UF_6 with SiH_4 in a low temperature SiH_4 matrix.** Jones, L.H.; Ekberg, S.A. (Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87545). *J. Chem. Phys.;* **71**: No. 11, 4764-4765(1 Dec 1979).

Results are reported that contradict the interpretation of Catalano et al.[2] for observing photoinduced reactions of UF_6 with SiH_4 in a low temperature SiH_4 matrix. It was found that the reactions occur due to near uv irradiation in the UF_6 A band (25 000—29 000 cm^{-1}) rather than the 613 cm^{-1} ν_3 absorption of UF_6.(AIP)

CHEMICAL AND PHYSICOCHEMICAL PROPERTIES

REFER ALSO TO CITATION(S) 2398, 2431, 2711, 3440, 3443, 3455

3422 (COO—4987-1) **Solid state, surface and catalytic properties of oxides. Progress report, August 1, 1978-September 30, 1979.** Kung, H.H. (Northwestern Univ., Evanston, IL (USA). Dept. of Chemical Engineering). Sep 1979. Contract ER-78-S-02-4987. 11p. Dep. NTIS, PC A02/MF A01.

The catalytic oxidative dehydrogenation of butene on iron containing oxides was studied in the hope of understanding the interrelationship among the bulk, the surface, and the catalytic properties of oxides. Our emphasis has been on the elucidation of the factors that determine the difference in selectivity for butadiene versus carbon dioxide on iron oxide and on zinc iron oxide, and on the determination of surface cation ratio in a solid solution of two binary oxides. It is found that the oxidation of butene to butadiene and to carbon dioxide takes place on two separate sites. A method was developed to determine the densities of these sites. The results showed that zinc iron oxide is a more selective oxidation catalyst

than iron oxide because it has a higher density of selective oxidation sites and a lower density of combustion sites, and because its combustion sites are less active than those on iron oxide. We have acquired the know-how to prepare oxide solution samples that show no charging when making surface composition measurements with Auger electron spectroscopy. Determination of surface cation ratios in $(Fe, Cr)_2O_3$ is underway. A preliminary calculation has been completed on the surface cation ratio of a solid solution of alkali halides.

3423 (FE—2727-5) **Mass transport characteristics of zeolite cracking catalysts. Quarterly report, October 1-December 31, 1978.** Haynes, H.W. Jr. (Mississippi Univ., University (USA). Dept. of Chemical Engineering). 12 Feb 1979. Contract EF-77-S-01-2727. 34p. Dep. NTIS, PC A03/MF A01.

The discrepancy between the experimental and calculated GC-diffusivity response curves noted in the last quarterly report have been confirmed with additional data on the n-butane/NaY system. The data contained in this report discount the possibility that system nonlinearities might be responsible for these discrepancies. We are now reasonably certain that these errors are a consequence of deficiencies in the axial dispersion model. It appears that this model does not apply when the axial dispersion coefficient significantly exceeds the value calculated from correlations intended for normal packed bed operation. This happens when a gas is passed through a bed of small particles (<1 mm) at high velocities. Studies of the catalytic cracking of n-butylbenzene, indan, tetralin, decalin and sym-octahydrophenanthrene over zeolite NaY were completed. Only partial results are given there. Generally speaking the product distribution from cracking each of these compounds was consistent with that which would be expected from thermal cracking (Rice-Kossiakoff mechanism). Coke deposition on the catalyst surface was surprisingly low considering the high severities involved. Some experimentation was conducted over zeolite NaA for comparison with the zeolite NaY results. These zeolites are very similar chemically. They differ primarily in their structural configuration. Because of the small pore structure of zeolite NaA it is reasonable to assume that any catalysis of these large hydrocarbon molecules occurs at the external crystallite surfaces. The product distributions from cracking over the two catalysts were similar, but the rates were lower by a factor of forty or more over the NaA catalyst. It seems certain that the higher reactivities of zeolite NaY are due to the ability of the reactants to penetrate the pore structure.

3424 (GEPP-TIS—457) **Investigation of cleaning reagents for calcium chromate spills.** Dillard, B.M. (General Electric Co., St. Petersburg, FL (USA). Neutron Devices Dept.). 9 Oct 1979. Contract EY-76-C-04-0656. 15p. Dep. NTIS, PC A02/MF A01.

Cleaning of calcium chromate spills can be a problem due to the insolubility of the material and the corrosiveness of several possible cleaning agents on the stainless steel equipment. Because of OSHA Standards for Cr(VI) exposure, it is necessary to remove spills as efficiently as possible in order to prevent the contaminant from becoming airborne. This study involved the comparison of several possible cleaning agents by studying the solubility of calcium chromate in each reagent. Two general types of reagents for dissolution of calcium chromate were investigated; those which act by conversion of the insoluble calcium chromate to a more soluble salt and to H_2CrO_4, and those which appear to act as complexing agents and thereby dissolve the calcium chromate. The most efficient of the reagents investigated was hydrochloric acid. However, even dilute solutions of halide acids destroy passivity of stainless steel causing pitting and stress-corrosion. Acetic acid and nitric acid were somewhat less efficient than hydrochloric acid in dissolving calcium chromate. However, both reagents are noncorrosive with stainless steel, nitric acid tending to favor passivity of the materials. Therefore, it is recommended that dilute solutions of either of these two acids be used for removal of calcium chromate spills in conjunction with mechanical methods that might be necessary, depending on the magnitude of the spill.

3425 (LBL—9571) **New equation of state for fluid water based on hard-sphere perturbation theory and dimerization equilibria.** Whiting, W.B.; Prausnitz, J.M. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Aug 1979. Contract W-7405-ENG-48. 9p. (CONF-790925—1). Dep. NTIS, PC A02/MF A01.

From 9. international conference on the properties of steam; Munich, F.R. Germany (10 Sep 1979).

The perturbation theory of Barker, Henderson, Alder, and others has been extended to gaseous and liquid water first by inclusion of Prigogine's parameter c to account for external degrees of freedom due to rotation and vibration and second by including chemical and hydrogen bonding. Water molecules are assumed to form dimers in chemical equilibrium with monomers in both liquid and vapor phases. Using our equation of state, which contains only two parameters characterizing the water molecule and a temperature-dependent dimerization constant, we fit the saturation pressure of water to within 0.1% (from the triple point to just below the critical point) and the saturated liquid and vapor volumes to within 1.8 and 3.2%, respectively. Superheated-steam and compressed-water volumes and enthalpies (to 800°C, 1000 bars) agree with experiment to within 1.2 and 5.4%, respectively. Consideration is also given to the effect of multiple associations (trimers, tetramers, etc.). Our equation may be useful for engineering applications where the above-quoted accuracy is adequate and where a relatively simple analytic equation of state is desirable for computational efficiency.

3426 (LBL—9788) **Thermodynamics of aqueous electrolytes at various temperatures, pressures, and compositions.** Pitzer, K.S. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Sep 1979. Contract W-7405-ENG-48. 30p. (CONF-791063—1). Dep. NTIS, PC A03/MF A01.

From Conference on thermodynamics of aqueous systems with industrial applications; Washington, DC, USA (22 Oct 1979).

It is shown that the properties of fully ionized aqueous electrolyte systems can be represented by relatively simple equations over wide ranges of composition. There are only a few systems for which data are available over the full range to fused salt. A simple equation commonly used for nonelectrolytes fits the measured vapor pressure of water reasonably well and further refinements are clearly possible. Over the somewhat more limited composition range up to saturation of typical salts such as NaCl, the equations representing thermodynamic properties with a Debye-Hueckel term plus second and third virial coefficients are very successful and these coefficients are known for nearly 300 electrolytes at room temperature. These same equations effectively predict the properties of mixed electrolytes. A stringent test is offered by the calculation of all of the solubility relationships of the system Na-K-Mg-Ca-Cl-So_4-H_20 and the calculated results of Harvie and Weare show excellent agreement with

3427 (LBL—9840) **X-ray absorption studies of graphite intercalates and metal-ammonia solutions.** Robertson, A.S. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Sep 1979. Contract W-7405-ENG-48. 248p. Dep. NTIS, PC A11/MF A01.

Thesis.

X-ray absorption spectroscopy (XAS) was used to study the arsenic fluorocomplexes, including the AsF_5 and AsF_6^- intercalates of graphite, and rubidium metal-ammonia solutions. The As-F distances obtained for AsF_3 and AsF_5 gas are both in excellent agreement with electron diffraction data (within 0.004 A). A superior measurement which is significantly shorter than the accepted value of the bond distance in an undistorted AsF_6^- octahedra is reported. Both the XAES and EXAFS data presented support the hypothesis that the AsF_5 oxidizes graphite upon intercalation to produce AsF_6^- and AsF_3 intercalant species. Changes in the Rb K-edge features which are consistent with the known properties of Rb-NH_3 are correlated with conductivity and delocalization of the solvated electrons. In the XAES region, intensity and position changes of absorption transitions are explained. In the EXAFS region, the Rb-N bond distance and the relative number of nitrogen atoms in the first shell are measured. XAS has been shown to provide unique information about the nature of the metal-ammonia phase separation, phase transition, and density fluctuations.

3428 (PNL—2842) **Chemistry of water and sediment from the benthic boundary layer at a site in the Northwest Atlantic Ocean.** Schmidt, R.L. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Jun 1979. Contract EY-76-C-06-1830. 50p. Dep. NTIS, PC A03/MF A01.

A primary objective of this study was to characterize the corrosive potential of the benthic boundary layer at a site where selected metal alloys were being exposed. Those properties of sea water and sediment likely to affect the corrosion of alloys that were measured in this study include salinity, pH, scale-forming cations, redox potential, dissolved gases, heavy metal ions, abrasive particulates, and microorganisms. The chemical properties of water from the benthic boundary layer do not appear to differ substantially from those of surface sea water. Salinity, pH and major ion content of this water appear to be representative of well-oxygenated, unpolluted oceanic water. On the basis of the properties examined, it is expected that corrosion of metals exposed in the deep sea would not differ greatly from that in surface waters having similar properties. However, the effect of pressure on corrosion rates and chemical forms of corrosion products may be an unknown factor of major importance. Increased calcite solubility at depth has been well-documented and the resulting inhibited formation of protective scale may be indicative of the effects of pressure on corrosion. The presence of sulfate-reducing bacteria in the bottom sediments at this site indicates that, if diffusion of O_2 into the sediment was inhibited, stainless steels buried in the mud would lose passivity and corrosion rates would increase. The eventual fate of corrosion products is dependent on their properties and the properties of their environment. In benthic boundary layer sea water it might be expected that corrosion products would be released as metal oxides. (JGB)

3429 **Crossed-beam study of the reaction H_3^+ (CO, H)HCO^+ at 1.89 eV.** Preuninger, F.N.; Bilotta, R.M.; Farrar, J.M. (Department

of Chemistry. University of Rochester, Rochester, New York 14627). *J. Chem. Phys.;* **71**: No. 10, 4166-4167(15 Nov 1979).

Employing a "seeded" supersonic nozzle source for the CO beam and a electrostatic energy analyzer-quadrupole mass spectrometer, the angular distribution and energy spectra of the reaction products were determined. (AIP)

3430 Stable gas phase hydrates of the CO^-_2 anion. Klots, C.E. (Chemical Physics Section, Health and Safety Research Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *J. Chem. Phys.;* **71**: No. 10, 4172(15 Nov 1979).

The observation of ions with the formula (H_2O)/sub x/ (CO_2)/sub y/$^-$ where x,y> or =1 is reported. The ions show no sign of autodetachment even for x=y=1. (AIP)

3431 Solar energy storage reactions. Determination of the structure of the complex formed by visible irradiation of $Rh_2(bridge)_4^{2+}$ in aqueous HCl solutions. Mann, K.R.; Bell, R.A.; Gray, H.B. (California Inst. of Tech., Pasadena). *Inorg. Chem.;* **18**: No. 10, 2671-2673(Oct 1979).

Visible irradiation of $Rh_2(bridge)_4^{2+}$ in concentrated HCl solutions yields hydrogen gas and a yellow complex, $Rh_2(bridge)_4Cl_2^{2+}$. An x-ray crystal structure analysis of $[Rh_2(bridge)_4Cl_2]Cl_2.8H_2O$ (bridge = 1,3-diisocyanopropane) has been completed (final R/sub F/ = 0.031). The complex crystallizes in the space group P2/sub 1//m(No. 11); a = 11.590 (4), b = 12.239 (4), c = 12.072 (4) A; β = 92.90 (2)°; Z = 2; d(calcd) = 1.686 (1), d(obsd) = 1.70 (2) g/cm³. The structure is composed of $Rh_2(bridge)_4Cl_2^{2+}$ cations having approximate D/sub 4h/ symmetry and a hydrogen-bonded network of Cl^- anions and water molecules. Each Rh atom is six-coordinate with Cl and Rh atoms in axial positions of a $Cl(RhC_4)Rh$ unit. The RhRh distance in the binuclear cation is 2.837 (1) A, and RhCl is 2.447 (1) A. The relative ease of reductive elimination of X from $Rh_2(bridge)_4X_2^{2+}$ (X = Cl, Br) complexes may be explained in part by the drive to reduce CC′ and NN′ nonbonded-atom repulsions that are caused by the close approach (~ 2.85 A) of the $Rh(CN)_4$ planes. 2 figures, 4 tables.

3432 Palladium-catalyzed coupling of tetraorganotin compounds with aryl and benzyl halides. Synthetic utility and mechanism. Milstein, D.; Stille, J.K. (Colorado State Univ., Fort Collins). Contract ER-78-S-02-4903.A000. *J. Am. Chem. Soc.;* **101**: No. 17, 4992-4998(15 Aug 1979).

Palladium complexes catalyze the coupling of tetraorganotin compounds with benzyl and aryl halides, benzylchlorobis(triphenylphosphine)palladium(II) (1) being the catalyst of choice. Various functional groups are tolerated by this reaction and generally high yields of the cross-coupled products are obtained. Oxygen has a considerable accelerating effect on the reaction, whereas triphenylphosphine has little effect. The reaction of substituted bromobenzenes with tetramethyltin catalyzed by 1 is accelerated by electron-withdrawing groups; however, a simple Hammett correlation is not observed. Optically active α-deuteriobenzyl bromide reacts with tetramethyltin to afford optically active α-deuterioethylbenzene with inversion of configuration. Homocoupling is the main reaction observed when lithium or Grignard reagents react with benzyl chloride under the influence of various palladium catalysts.

3433 Syntheses and electronic structures of decamethylmanganocenes. Robbins, J.L.; Edelstein, N.M.; Cooper, S.R.; Smart, J.C. (Univ. of California, Berkeley). *J. Am. Chem. Soc.;* **101**: No. 14, 3853-3857(4 Jul 1979).

The syntheses of $[(C_5(CH_3)_5)_2Mn]PF_6$, $(C_5(CH_3)_5)_2Mn$, and $Na[(C_5(CH_3)_5)_2Mn]$ are described. Magnetic susceptibility, infrared, electrochemical, NMR, and reactivity studies suggest the formulation of these complexes as low-spin 16-, 17-, and 18-electron planar metallocenes. EPR spectra of the neutral complex are consistent with the ^2E/sub 2g/ configuration determined for other low-spin 17-electron metallocenes. 1 figure, 3 tables.

3434 Sodium tetramolybdenum hexoxide ($NaMo_4O_6$). A metallic infinite-chain polymer derived by condensation of octahedral clusters. Torardi, C.C.; McCarley, R.E. (Ames Lab., IA). Contract 7405-ENG-82. *J. Am. Chem. Soc.;* **101**: No. 14, 3963-3964(4 Jul 1979).

The synthesis and structure of $NaMo_4O_6$, which contains octahedral cluster units welded on opposite edges to form linear chains, were reported. This new compound represents the result of condensation of cluster units, a consequence of progressive lowering of nonmetal/metal ratio. One way to achieve lower nonmetal/metal ratios was by substitution of divalent nonmetal atoms for monovalent atoms in the structure. Intensive examinations of properties are currently being studied. 2 figures.

3435 Preparation and characterization of a europium(II) bromide-chloride phase $EuBr_{1.5}Cl_{0.5}$. Clink, B.L.; Eick, H.A. (Michigan State Univ., East Lansing). *J. Solid State Chem.;* **28**: No. 3, 321-328(Jun 1979).

A divalent europium chloride-bromide phase, EuBr/sub 1.56(7)/Cl/sub 0.46(2)/ has been prepared and identified on the basis of analytical, x-ray powder diffraction and single-crystal data. Although the phase is considered isostructural with $EuCl_2(PbCl_2$ structure type, α = 0.9230(5), b = 0.7890(4), c = 0.4613(3) nm, space group Pbnm), the single-crystal data indicate long-range order in the form of a superstructure which doubles the b parameter. In the pseudocell the square pyramidal anion sites are occupied principally by bromide ions, the tetrahedral sites almost equally by bromide and chlorine ions. Structural details and the long-range order are discussed. Evidence is presented for the existence of another europium(II) mixed halide phase, EuBr/sub 1.8(2)/Cl/sub 0.16(2). 5 tables.

3436 Mixed-valent $Ba_2Bi^{3+}Bi^{5+}O_6$: structure and properties vs temperature. Cox, D.E. (Brookhaven National Lab., Upton, NY); Sleight, A.W. Contract EY-76-C-02-0016. *Acta Crystallogr., Sect. B;* **35**: 1-10(1979).

The structure of the ordered perovskite-like compound $Ba_2Bi^{3+}Bi^{5+}O_6$ has been determined by x-ray and neutron powder diffraction techniques over the temperature range 295 to 723 K. A first-order transition from monoclinic to rhombohedral occurs at about 405 K. Profile refinement of the neutron data shows that a satisfactory description of both structures can be given in terms of tilting of rigid BiO_6 octahedra, the transition corresponding to an abrupt change in the tilt axis from pseudocubic [110] to [111]. The respective space groups are I2/m and R3, and the Bi^{3+} and Bi^{5+} ions retaining their ordered arrangement in the rhombohedral phase. The analysis also reveals considerable anisotropy in the thermal vibrations of the oxygen ions. The rms amplitude perpendicular to the Bi-O bond is about double that along the bond, consistent with the rigid-octahedron picture. The data further indicate that there is a transition to cubic symmetry at about 750 to 800 K. The 405 K transition in $BaBiO_3$ is strikingly similar to the 205 K transition in $PrAlO_3$.

3437 Bonding of metal oxides in sodium silicate glass. Lam, D.J.; Veal, B.W.; Chen, H.; Knapp, G.S. (Argonne National Lab., IL). pp 97-107 of Scientific basis for nuclear waste management. McCarthy, G.J. (ed.). New York, NY; Plenum Press (1979).

From Annual meeting of Materials Research Society; Boston, MA, USA (28 Nov 1978).

X-ray photoelectron spectroscopy (XPS) and extended x-ray absorption fine structure (EXAFS) studies have been undertaken on sodium disilicate glasses containing varying amounts of Fe_2O_3 and UO_2. The XPS results enable one to distinguish the different bonding characteristics of iron and uranium in these glasses. A three dimensional model for the iron coordination in the sodium disilicate glass is inferred from the combined XPS and EXAFS results.

3438 Electronic structure of transition metal hydrides. Switendick, A.C. (Sandia Labs., Albuquerque, NM). *Adv. Chem. Ser.;* No. 167, 264-282(1978).

Metal hydrides form crystalline solids of various types ranging from ionic crystals through semiconductors to metals. They also can be considered as perhaps the simplest example of a class of solid state systems called interstitial alloys wherein a nonmetallic element (hydrogen) is incorporated into an empty hole in a simple metal lattice. The effect of this incorporation on the structure and electronic properties of the metal has been investigated theoretically using the solid state counterpart of molecular orbital theory-band structure theory. Results of these calculations are given for a prototype dihydride system TiH_2 and the well-studied monohydride PdH. In particular, the nature of the metal-hydrogen bond and hydrogen-hydrogen interactions are elucidated.

3439 Energy-transfer processes in proton-excited Ar-Xe and Ar-F_2 mixtures. Chen, C.H.; Judish, J.P.; Payne, M.G. (Oak Ridge National Lab., TN). *J. Phys., B (London);* **11**: No. 12, 2189-2199(1978).

Mixtures of Ar and Xe and of Ar and F_2 were excited with pulsed proton beams and time-resolved spectroscopy was employed to study energy transfer from Ar to Xe or F_2. Measurements were made of the quenching rates of $Ar(^1P_1)$, $Ar(^3P_1)$ and $Ar_2(1$/sub u/) by Xe and F_2. The energy precursors of $Xe(^1P_1)$ and $Xe(^3P_1)$ and $Xe(^3P_2/_2(5d),J = 1)$ are identified from $Ar_2(1$/sub u/), $Ar_2(1$/sub u/) and $Ar(^3P_1)$, respectively. Excimers of ArF are populated by $Ar(^3P_2)$ and $Ar_2(1$/sub u/) from the energy-transfer process and the ion-ion recombination process by argon and fluorine ions.

ISOTOPE EFFECTS

REFER ALSO TO CITATION(S) 2601, 3432

3440 Mechanism of reductive elimination. Reaction of alkylpalladium(II) complexes with tetraorganotin, organolithium, and Grignard reagents. Evidence for palladium(IV) intermediacy. Milstein, D.; Stille, J.K. (Colorado State Univ., Fort Collins). Contract ER-

78-S-02-4903.A000. *J. Am. Chem. Soc.;* **101**: No. 17, 4981-4991(15 Aug 1979).

Coupling products are obtained in good yields from the reaction of tetraorganotin compounds or Grignard reagents and organohalogenopalladium(II) complexes provided that a benzyl bromide is present. Low yields are obtained in the absence of the benzyl bromides, in which case other decomposition pathways (e.g., α elimination) take place, even in the presence of electron acceptors (e.g., oxygen, m-dinitrobenzene). The first step in the reaction of benzylhalogenobis(triphenylphosphine)-palladium(II) complexes with MeM (M = $SnMe_3$, MgBr) is metathesis of the benzyl ligand rather than the halogen. This unique carbon-for-carbon transmetalation takes place at 25°C and is facilitated by electron-donating substituents on the benzyl ligand. The products of this reaction subsequently react at higher temperature in the presence of a benzyl bromide to afford ethylbenzene. Optically active chloro-(α-deuteriobenzyl)bis(triphenylphosphine)palladium yields, upon reaction with tetramethyltin in the presence of p-nitrobenzyl bromide, optically active α-deuterioethylbenzene in which overall retention of configuration at carbon has resulted. cis-dimethylbis(triphenylphosphine)palladium(II) reacts with benzyl bromide at 25°C to afford ethylbenzene and bromomethylbis(triphenylphosphine)palladium(II) rather than ethane. When optically active α-deuteriobenzyl bromide is used in this reaction, optically active α-deuterioethylbenzene is formed, and inversion of configuration at carbon takes place. The reductive elimination process is proposed to take place preferentially from a palladium(IV) intermediate with retention of configuration at carbon.

3441 J-cross polarization in silanes. Murphy, P.D.; Taki, T.; Sogabe, T.; Metzler, R.; Squires, T.G.; Gerstein, B.C. (Ames Lab., IA). Contract W-7405-ENG-82. *J. Am. Chem. Soc.;* **101**: No. 15, 4055-4058(18 Jul 1979).

The first cross-polarization NMR experiment between ^1H and ^{29}Si in the liquid state with rare-spin observation is reported. A line-shape-fitting technique is employed to directly measure the spin coupling constant, J, from the experimental results of initial magnetization vs. cross-polarization contact time. The technique has been used to enhance sensitivities of ^{29}Si measurements in Si-O-model compounds.

ISOTOPE EXCHANGE AND ISOTOPE SEPARATION

REFER ALSO TO CITATION(S) 3474

ORGANIC CHEMISTRY

CHEMICAL AND PHYSICOCHEMICAL PROPERTIES

REFER ALSO TO CITATION(S) 2426, 2508, 2708, 3418, 3422, 3423, 3431, 3432, 3433, 3467

3442 Tris(dialkylamino)phosphine with pyramidal nitrogens. White, D.W.; Karcher, B.A.; Jacobson, R.A.; Verkade, J.G. (Ames Lab., IA). *J. Am. Chem. Soc.;* **101**: No. 17, 4921-4925(15 Aug 1979).

Syntheses for the unstable symmetrical tricyclic aminophosphine 1 and its relatively stable O=P (2), S=P (3), and Se=P (4) derivatives are reported. The failure of 1 to form a stable BH_3 adduct contrasts with that observed for $P(NMe_2)_3$, $P(MeNCH_2)_3CMe$, and $P(NCH_2CH_2)_3$ and is rationalized in terms of electronic differences on the nitrogen which are imposed by structural constraints. The trend in ^1J/sub PSc/ for these compounds is shown to be consistent with this idea. The structure of 3, determined by x-ray means, substantiates our earlier postulate that constraint in $P(ZC)_3$ systems decreases the PZC angle before the ZPZ angle is affected.

3443 Host-guest complexation. 18. Effects on cation binding of convergent ligand sites appended to macrocyclic polyethers. Helgeson, R.C.; Weisman, G.R.; Toner, J.L.; Tarnowski, T.L.; Chao, Y.; Mayer, J.M.; Cram, D.J. (Univ. of California, Los Angeles). Contract AT(04-3)-34. *J. Am. Chem. Soc.;* **101**: No. 17, 4928-4941(15 Aug 1979).

Syntheses are reported for 16 new macrocyclic polyether ligand systems which contain potentially convergent side chains containing additional binding sites. The free energies of association of these systems in $CDCl_3$ at 25°C with Li^+, Na^+, K^+, Rb^+, Cs^+, NH_4^+, $CH_3NH_3^+$, and t-$BuNH_3^+$ picrates were determined.

3444 Chromopeptides from C-phycocyanin. Structure and linkage of a phycocyanobilin bound to the β subunit. Lagarias, J.C.; Glazer, A.N.; Rapoport, H. (Univ. of California, Berkeley). *J. Am. Chem. Soc.;* **101**: No. 17, 5030-5037(15 Aug 1979).

The smallest cyanogen bromide fragment derived from the β subunit of Synechococcus sp. 6301 C-phycocyanin, the blue heptapeptide 2, has been investigated by 360-MHz ^1H NMR spectroscopy. The peptide portion, heptapeptide 3, was synthesized independently and used in comparative spectroscopic analysis. These studies have led to complete assignment of the structure of the peptide-linked phycocyanobilin and elucidation of the nature of the thioether chromophore-peptide linkage.

3445 Liquid-solid-liquid triphase catalysis. Consideration of the rate-limiting step, role of stirring, and catalyst efficiency for simple nucleophilic displacement. Regen, S.L.; Besse, J.J. (Marquette Univ., Milwaukee, WI). *J. Am. Chem. Soc.;* **101**: No. 15, 4059-4063(18 Jul 1979).

The kinetics of the triphase catalyzed displacement of chloride ion on n-decyl methanesulfonate employing a series of 1% cross-linked polystyrene resins having pendant tri-n-butylphosphonium groups has been investigated. The rate of displacement (1) exhibited a pseudo-first-order dependency on the mesylate concentration, (2) was directly proportional to the amount of catalyst used, (3) was independent of stirring, (4) was characterized by a free energy of activation of ~ 30 kcal mol^{-1}, and (5) depended on the catalyst-ion concentration in the resin. In addition, reaction was favored at the external portion of the bead. Taken together, these observations provide strong support that a diffusion-limited chemical reaction is the rate-controlling step. When large quantities of polymer were employed, stirring was needed to increase resin contact with the liquid-liquid interface. Consideration of apparent activation energies, and absorption of n-decyl methanesulfonate in the catalysts, supports the conclusion that inefficient use of ionic sites dispersed throughout the resins is responsible for the low activity observed.

3446 Photoelectron spectroscopy of methyl, ethyl, isopropyl, and tert-butyl radicals. Implications for the thermochemistry and structures of the radicals and their corresponding carbonium ions. Houle, F.A.; Beauchamp, J.L. (California Inst. of Tech., Pasadena). *J. Am. Chem. Soc.;* **101**: No. 15, 4067-4074(18 Jul 1979).

The first photoelectron bands of the series of simple alkyl free radicals CH_3, CH_3CH_2, CH_3CD_2, CH_3CHCH_3, and $C(CH_3)_3$ have been obtained. The adiabatic and vertical ionization potentials, respectively, are 9.84 +- 0.02 eV for methyl radical, 8.39 +- 0.02 and 8.51 +- 0.02 eV for ethyl radical, 8.38 +- 0.02 and 8.50 +- 0.02 eV for ethyl-1,1-d_2 radical, 7.36 +- 0.02 and 7.69 +- 0.02 eV for isopropyl radical, and 6.70 +- 0.03 and 6.92 +- 0.03 eV for tert-butyl radical. The heats of formation of the corresponding carbonium ions are calculated to be 261.8 +- 0.5 kcal/mol for methyl cation, 219.2 +- 1.1 kcal/mol for ethyl cation, 187.3 +- 1.1 kcal/mol for isopropyl cation, and 162.9 +- 1.2 kcal/mol for tert-butyl cation. The implications of these data for the gas-phase proton affinity scale are explored. Band structure is resolved, and possible assignments are presented. The results are discussed in terms of the interactions of methyl groups with trigonal carbon radical and ion centers.

3447 Study of the forces responsible for binding of polar substrates in the cyclohexaamylose cavity by positron annihilation techniques. Hall, E.S.; Ache, H.J. (Virginia Polytechnic Inst. and State Univ., Blacksburg). Contract EY-76-S-05-3602. *J. Phys. Chem.;* **83**: No. 14, 1805-1807(12 Jul 1979).

The complex formation constants for a series of inclusion complexes of p-, m-, and o-nitrophenol and p-, m-, and o-nitrobenzyl alcohol with cyclohexaamylose were determined by positron annihilation techniques. The formation constants, K/sub c/, were found to be 341, 54, 8, 28, 25, and 9 M^{-1}, respectively. The results seem to suggest that hydrogen bonding and/or London dispersion forces are mainly responsible for the binding of these guest molecules in the cyclohexaamylose cavity, while hydrophobic interactions play only a minor role in these systems. In the ortho isomers, complex stability is greatly reduced due to steric hindrance. 1 table.

3448 Effects of temperature and electric field on the visible polarized transmission spectra of several orientationally disordered crystals. Klingen, T.J. (Univ. of Mississippi, University); Sherman, L.R. Contract EY-76-S-05-3781. *J. Phys. Chem.;* **83**: No. 14, 1876-1879(12 Jul 1979).

Investigation of the polarized visible light transmission spectra of orientationally disordered (plastic) crystals as a function of applied electric field and temperature has shown a relationship between the transmitted light intensity and the rotational freedom of the mesophase. In the α mesophase, an Arrhenius type relationship was observed for 1-vinyl-o-carborane between 298 and 348 K and for 1-bromoadamantane between 308 and 348 K. The calculated rotational energies of these compounds from the Arrhenius relationships were determined to be 17.2 and 26.4 kJ/mol, respectively. These values are in reasonably good agreement with the rotational energy barriers reported in the literature for these spherical compounds from NMR studies. 4 figures, 2 tables.

3449 Studies on the temperature dependent phosphorescence of poly(N-vinylcarbazole). Burkhart, R.D.; Aviles, R.G. (Univ. of Nevada, Reno). Contract AT(26-1)-535. *J. Phys. Chem.;* **83**: No. 14, 1897-1901(12 Jul 1979).

Phosphorescence lifetimes and spectra of solid films of poly(N-vinylcarbazole) (PVCA) have been obtained at temperatures between 77 and 298 K. The presence of two trapped triplet species is confirmed and their energies are found to be 1.97×10^4 and 2.12×10^4 cm^{-1}. At 77 K the deep trap has a lifetime of 1.7 +- 0.08 s and the shallow trap 7.7 +- 0.6 s. Activation energies for the decay of these two triplets are 1000 cm^{-1} for the deep trap and 200 cm^{-1} for the shallow trap. Assuming these activation energies represent trap depths below the mobile triplet level, one finds that the energy of mobile triplets is $\sim 2.1 \times 10^4$ cm^{-1} which places it about 2000 cm^{-1} below the isolated carbazolyl triplet. Effects of solvent and techniques employed in film formation are found to have minor influences on lifetimes or spectra. 5 figures.

3450 Study of transient phenomena in the reactions of alkoxy radicals with triphenylphosphine and triphenylborane. Griller, D.; Ingold, K.U.; Patterson, L.K.; Scaiano, J.C.; Small, R.D. Jr. (Univ. of Notre Dame, IN). *J. Am. Chem. Soc.;* **101**: No. 14, 3780-3785(4 Jul 1979).

Alkoxytriphenylphosphoranyl and boranyl radicals have been observed using optical absorption spectroscopy. Kinetic measurements of the formation of these species provide the first absolute measurements of radical attack at the phosphorus and boron centers. For tert-butoxy radical attack at 22°C the rate constants are 1.9×10^9 and $1 \times 10^8 M^{-1}s^{-1}$ for Ph_3P and Ph_3B, respectively. The radicals so produced decay with lifetimes of 900 and 15 μs, respectively. Methoxytriphenylphosphoranyl radicals are produced in the radiolysis of methanolic solutions of triphenylphosphine; a reinterpretation of earlier experiments in the field is suggested. In the case of triphenylphosphine the radicals have been examined using laser flash photolysis, ESR spectroscopy, pulse radiolysis, and conventional flash photolysis, the various techniques providing mutually supporting results. In the case of triphenylborane our results provide for the first time conclusive evidence for the stepwise nature of radical reaction at the boron center. 5 figures, 2 tables.

3451 Reaction of a metal alkyl with ethylene as a model for Ziegler-Natta polymerization. Evidence for the olefin insertion mechanism. Evitt, E.R.; Bergman, R.G. (California Inst. of Tech., Pasadena). Contract W-7405-ENG-48. *J. Am. Chem. Soc.;* **101**: No. 14, 3973-3974(4 Jul 1979).

A labeling study was carried out which demonstrates (in agreement with the classical view) that insertion, rather than α-elimination, is the critical step in the mechanism of this reaction. A 0.13M benzene-d_6 solution of 1(cobalt complex) was heated under 4 atm of ethylene for 30 hours at 76°C in a sealed NMR tube, the absorptions characteristic of 1 (Σ4.49, 0.61 ppM) and ethylene (5.27) were replaced by those from methane (0.22) and propene (1.58, CH_3), as well as by a new cyclopentadienyl signal (5.50, 5H) and two new multiplets at 1.11 (2H) and 2.09 (2H) ppM.

3452 Solubility of toluene in aqueous solutions of various benzenecarboxylates with or without 1-butanol. Ho, P.C.; Ogden, S.B. (Oak Ridge National Lab., TN). *J. Chem. Eng. Data;* **24**: No. 3, 234-237(Jul 1979).

Miscibility relationships in systems containing short alkyl-side-chain sodium benzenecarboxylats, toluene, and water without (three-component systems) or with (four-component systems) 1-butanol were studied at 55 and 25°C, respectively. The results are compared with corresponding sulfonates. The benzenecarboxylates included those of benzene, 2,4-dimethylbenzene, 2,4,6-trimethylbenzene, and tert-butylbenzene. The solubility of toluene in aqueous solutions of the carboxylates increases with the number of alkyl carbons N/sub AC/ attached to the benzene ring and generally with carboxylate concentration (up to ca. 3 mole/kg of H_2O); it is somewhat higher in the carboxylate solutions than in the corresponding sulfonate solutions. Four-component systems were treated as pseudoternary systems by maintaining a constant carboxylate to water ratio (2 mole/kg of water). Boundaries between one and two phases are fairly symmetrical. The amount of 1-butanol (cosolvent) required to produce miscibility decreases with increasing number of alkyl carbons on the carboxylate. These systems required somewhat less 1-butanol to produce miscibility than the corresponding sulfonate systems. 4 figures, 3 tables.

3453 Enthalpies of combustion of the isomeric pentenes in the liquid state. A warning to combustion calorimetrists about sample drying. Good, W.D.; Smith, N.K. (Bartlesville Energy Research Center, OK). *J. Chem. Thermodyn.;* **11**: 111-118(1979).

The liquid-state enthalpies of combustion of the isomeric pentenes were measured by precision oxygen-bomb combustion calorimetry. The following values, based on the mass of carbon dioxide formed by combustion of the compound, are reported for the standard enthalpy of combustion, $\Delta H_c°(298.15\ K)/kJ\ mol^{-1}$, in the liquid state: 1-pentene, -(3349.72 +- 0.58; cis-2-pentene, -(3343.21 +- 0.54); trans-2-pentene, -(3338.71 +- 0.70); 2-methyl-1-butene, -(3335.74 +- 0.80); 3-methyl-1-butene, -(3345.10 +- 0.54); and 2-methyl-2-butene, -(3328.62 +- 1.26). An unexpected problem in this research was the isomerization that occurred when vapors of 2-methyl-1-butene and 2-methyl-2-butene were passed over molecular sieve. Early experiments with these two compounds were abandoned when g.l.c. analysis showed that isomerization had occurred, and the experiments were repeated without sample drying. Because of the possibility of water in the samples of these two compounds, the mass of carbon dioxide in the combustion products rather than the mass of reacting sample was used as the measure of the extent of reaction for the experiments with all six isomeric pentenes.

ISOTOPE EFFECTS

REFER ALSO TO CITATION(S) 3432, 3446

3454 Assignments of ^1H nuclear magnetic resonances of the cystyl, asparaginyl, and aromatic residues of arginine vasopressin in D_2O. A comparison with lysine vasopressin and oxytocin in terms of solution conformation. Wyssbrod, H.R.; Fischman, A.J.; Live, D.H.; Hruby, V.J.; Agarwal, N.S.; Upson, D.A. (Mount Sinai Medical and Graduate Schools, New York, NY). *J. Am. Chem. Soc.;* **101**: No. 15, 4037-4043(18 Jul 1979).

The resonances of the C/sup α/ and C/sup β/ protons of the cystyl, asparaginyl, and aromatic residues of [8-arginine]vasopressin (AVP) in D_2O at pD 3.8 and 20°C were assigned in a rigorous manner by the use of isotopic isomers of AVP that contain specific replacements of protons by deuterons and by comparison of ^1H NMR characteristics of AVP to those of [8-lysine]vasopressin (LVP) and oxytocin (OT). Although there is extensive overlap of resonances of C/sup β/ protons even at 360 MHz, all of the chemical shifts of these protons and most of the couplings between them and their vicinal C/sup α/ protons could be determined, at least to a first approximation. It was concluded that the cyclic moieties (residues 1-6) of AVP, LVP, and OT possess essentially the same overall backbone conformation, and that the side-chain conformation - or rotamer populations - about the C/sup α/-C/sup β/ bonds of the cystyl residue (positions 1 and 6), the tyrosyl residue (position 2), and the asparaginyl residue (position 5) are similar. This study indicates that selective replacements of C/sup β/ protons by deuterons are necessary to improve the accuracy of coupling constants extracted from 360-MHz spectra of a AVP for use in conformational analysis.

ELECTROCHEMISTRY

REFER ALSO TO CITATION(S) 3230, 3358

PHOTOCHEMISTRY

REFER ALSO TO CITATION(S) 2573, 3462

3455 (LBL—8580, pp 221-400) **Chemical sciences.** 1978.

In Materials and Molecular Research Division annual report, 1978.

Topics covered include: photochemical and radiation sciences, chemical physics, atomic physics, chemical energy, chemical engineering, heavy element chemistry, and coal research.

3456 (LBL—9782) **Resonant multiphoton dissociation of small molecules.** Kung, A.H.; Dai, H.L.; Berman, M.R.; Moore, C.B. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jun 1979. Contract W-7405-ENG-48. 14p. (CONF-790690—4). Dep. NTIS, PC A02/MF A01.

From 4. international conference on laser spectroscopy; Rottach-Egern, Tegernsee, F.R. Germany (11 Jun 1979).

Multiphonon dissociation (MPD) of ethyl chloride and deuterated formaldehyde was studied. The vibrational energy levels of a molecule is divided into three regions for understanding MPD. MPD dydamics are probably similar for all molecules in regions II and III, but in region I depend greatly on molecular structure and spectra. 7 figures, 1 table. (DLC)

3457 (SAN—0034-240-T1) **Photo induced electron transfer reactions in mixed organic-inorganic systems. Final report.** Hammond, G.S. (California Univ., Santa Cruz (USA); Allied Chemical Corp., Morristown, NJ (USA)). 12 Sep 1979. Contract EY-76-S-03-0034-240. 6p. Dep. NTIS, PC A02/MF A01.

Fluorescence quenching of two organic cations by metal ions was studied: N-methyl-acridinium and triphenyl pyraninium The fluorescence of both cations was quenched by metal ions but reactivities in quenching did not correlate uniquely to the oxidation potentials of the metal cations.

3458 UV laser photochemistry of CF_2Br_2. Wampler, F.B.; Tiee, J.J.; Rice, W.W.; Oldenborg, R.C. (Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *J. Chem. Phys.;* **71**: No. 10, 3926-3930(15 Nov 1979).

CF_2Br_2 has been irradiated at room temperature with KrF (248.4 nm) and ArF (193.3 nm) lasers. The fluorescence produced by the KrF laser irradiation appears to consist of only two ν_2 progressions, $v'_2=6$ and 5 for the CF_2 ($^1B_1$-X $^1A_1$) transition. The collision-free lifetime of the CF_2 emission was found to be 59 ns. The fluence dependence of the emission is quadratic. Upon irradiation of CF_2Br_2 with an ArF laser various emitting species were noted. Emission from CF(A $^2\Sigma^+$—X ^{2}Pi), CF(B $^2\Delta$—X ^{2}Pi), CF_2($^2B_1$—X $^1A_1$), and Br_2(^{3}Pi/sub o/+u—$^1\Sigma^+$ /sub g/) molecules was noted. Laser-induced fluorescence excitation spectra confirmed the presence of CF_2. The ArF laser fluence dependence of CF_2(X $^1A_1$) formation was found to be 1.0.

3459 Photobehavior of copper(I) compounds. Role of copper(I)-phosphine compounds in the photosensitized valence isomerization of norbornadiene. Grutsch, P.A.; Kutal, C. (Univ. of Georgia, Athens). *J. Am. Chem. Soc.;* **101**: No. 15, 4228-4233(18 Jul 1979).

The valence isomerization of norbornadiene to quadricyclene can be photosensitized with high quantum efficiency by certain copper(I)-phosphine compounds. Sensitization yields in the presence of $Cu(PPh_3)_2BH_4$ and $Cu(PPh_2Me)_3BH_4$ attain limiting values of 0.76 and 0.54, respectively, at high norbornadiene concentrations. In contrast, Cu(diphos)BH_4 (diphos is 1,2-bis(diphenylphosphino)ethane), which contains a bidentate phosphine ligand, is decidely less effective. The mechanism of sensitization by these copper(I)-phosphine compounds is fundamentally different from that exhibited by simple cuprous salts in that no ground-state coordination to the metal center occurs. A pathway involving the bimolecular interaction of the photoexcited Cu(I) compound with a ground-state norbornadiene molecule is better able to accommodate the available data. Electronic absorption and emission studies reveal some interesting differences between the spectral properties of effective vs. noneffective sensitizers.

3460 Demonstration of Woodward-Hoffmann behavior in the pulsed, infrared laser induced reaction of cis-3,4-dichlorocyclobutene. Danen, W.C.; Koster, D.F.; Zitter, R.N. (Los Alamos Scientific Lab., NM). *J. Am. Chem. Soc.;* **101**: No. 15, 4281-4283(18 Jul 1979).

The pulsed, infrared laser induced reaction of cis-3,4-dichlorocyclobutene has been demonstrated to produce cis,-trans-1,4-dichloro-1,3-butadiene as the only detectable product even though the reaction system was not at thermal equilibrium. This is the isomer predicted by the Woodward-Hoffmann rules of conservation of orbital symmetry for a thermally allowed, ground-state, conrotatory ring opening. Even at relatively short laser pulses, reaction via a higher energy, nonallowed channel or biradical intermediate could not be made competitive within the experimental detection limit.

3461 Early events and transient chemistry in the photohomolysis of alkylcobalamins. Endicott, J.F. (Wayne State Univ., Detroit, MI); Netzel, T.L. *J. Am. Chem. Soc.;* **101**: No. 14, 4000-4002(4 Jul 1979).

Studies of the transient intermediates generated following irradiations of methyl- and adenosylcobalamin are reported. While the present study has involved organocobalt substrates, the general features are expected to be characteristic of photohomolysis in most transition metal complexes. More specifically in these systems for which phi/sub R/ is a constant over an appreciable range of excitation energies greater than E/sub th/. There will be considerable excited-state thermalization, and numerical values of phi/sub R/ will be a function of both excited-state dynamics and radical pair recombination statistics. 1 figure, 1 table.

RADIATION CHEMISTRY

REFER ALSO TO CITATION(S) 3565

3462 (COO—3416-13) **Photochemistry and radiation chemistry of volatile silanes and germanes. Progress report, September 1, 1978-August 31, 1979.** Lampe, F.W. (Pennsylvania State Univ., University Park (USA)). 1979. Contract EY-76-S-02-3416. 34p. Dep. NTIS, PC A03/MF A01.

The following are reported: reactions of methyl cations with ethylsilanes; reactions of ethyl, propyl, and butyl cations with methyl and ethylsilanes; the 147-nanometer photolysis of disilane; lifetimes and collisional stabilization of chemically activated ethylsilyl cations; formation of GeH_5^+ and the proton affinity of GeH_4; and multiphoton infrared decomposition of silanes.

3463 Nanosecond time-resolved EPR in pulse radiolysis via the spin echo method. Trifunac, A.D.; Norris, J.R.; Lawler, R.G. (Chemistry Division, Argonne National Laboratory, Argonne, Illinois 60439). *J. Chem. Phys.;* **71**: No. 11, 4380-4390(1 Dec 1979).

The design and operation of a time-resolved electron spin echo spectrometer suitable for detecting transient radicals produced by 3 MeV electron radiolysis is described. Two modes of operation are available: Field swept mode which generates a normal EPR spectrum and kinetic mode in which the time dependence of a single EPR line is monitored. Techniques which may be used to minimize the effects of nonideal microwave pulses and overlapping sample tube signals are described. The principal advantages of the spin echo method over other time-resolved EPR methods are: (1) Improved time resolution (presently ~30—50 nsec) allows monitoring of fast changes in EPR signals of transient radicals, (2) Lower susceptibility to interference between the EPR signal and the electron beam pulse at short times, and (3) Lack of dependence of transient signals on microwave field amplitude or static field inhomogeneity at short times. The performance of the instrument is illustrated using CIDEP from acetate radical formed in pulsed radiolysis of aqueous solutions of potassium acetate. The relaxation time and CIDEP enhancement factor obtained for this radical using the spin echo method compare favorably with previous determinations using direct detection EPR. Radical decay rates yield estimates of initial radical concentrations of 10^{-4}-10^{-3}M per electron pulse. The Bloch equations are solved to give an expression for the echo signal for samples exhibiting CIDEP using arbitrary microwave pulse widths and distributions of Larmor frequencies. Conditions are discussed under which the time-dependent signal would be distorted by deviations from an ideal nonselective 90°—tau—180° pulse sequence.

3464 Radiation damage studies by x-ray photoelectron spectroscopy. III. Electron irradiated halates and perhalates. Sasaki, T.; Williams, R.S.; Wong, J.S.; Shirley, D.A. (Materials and Molecular Research Division, Lawrence Berkeley Laboratory). *J. Chem. Phys.;* **71**: No. 11, 4601-4610(1 Dec 1979).

X-ray photoelectron spectroscopy (XPS) was employed to identify radiolytic products in $NaClO_3$, $LiClO_3$, $LiBrO_3$, and $LiIO_4$ which were irradiated in situ with 1.4 keV electrons. While $LiIO_4$ was exceedingly resistant to radiation damage, the remaining compounds decomposed readily by an apparent stepwise release of oxygen from the parent oxyanion to form XO^-_3, XO^-_2, X^- (X=Cl or Br) and O_2. Heavy irradiation produced IO^-_3 in $LiIO_4$ and alkali halide, and alkali-metal oxide in the remaining compounds. These final products were cathodochromic, with both trapped electron (F or anion vacancy) and hole (V/sub k/ or X^-_2) centers being formed. Photobleaching of these centers also induced a partial reoxidation of the halogen species that had been formed by radiation-induced reduction. Comparison of the production rate of Li_2O with that of $X^-_2+X^-$ suggests that Li_2O is not a primary product,but may be produced via oxidation of colloidal particles of metallic lithium in the alkali halide layer of the heavily irradiated samples.

3465 ESR study of chlorine containing radicals in x-irradiated N-chlorosuccinimide at 77 K. Pace, D.; Ezell, K.; Kispert, L.D. (Chemistry Department, The University of Alabama, Tuscaloosa, Alabama 35486). *J. Chem. Phys.;* **71**: No. 10, 3971-3975(15 Nov 1979).

Three different radicals were identified by ESR studies in x-irradiated single crystals of N-chlorosuccinimide; radicals I and II, stable at 77 K and radical III, stable at 240 K. Radical I was identified as the previously reported sigma anion radical, >N-Cl⁻. Radical II was found difficult to saturate at 200 mW and was assigned to a chlorine atom interacting weakly with a nearby nitrogen with g/sub z/=2.008, g/sub x/=2.120, and g/sub y/=2.126. The chlorine and nitrogen hyperfine couplings were found to be A/sub z/=116.0, A/sub x/=6.4, A/sub y/=4.2 G, and A/sub z/=8.4, A/sub x/=4.7 and A/sub y/=4.4 G, respectively. At 240 K, radical III was formed by the abstraction of a ring proton from a neighboring N-chlorosuccinimide molecule when radical I decayed.

3466 Radiolysis of naphthalene, n-hexane solutions. Keyser, R.M.; Slusher, R.; Parkinson, W.W. Jr. (Oak Ridge National Lab., TN (USA)). *Int. J. Appl. Radiat. Isot.;* **29**: No. 6, 373-379(Jun 1978).

To explore the feasiblity of radiation processing of aromatics such as those in coal, solutions of naphthalene in n-hexane have been irradiated with ^{60}Co gamma rays at doses up to 2 x 10^{22} eV/g (3 x 10^6 rad). The yield for incorporation of naphthalene in radiation products was about G = 1 at 0.10 mole fraction naphthalene. Over half the naphthalene in the radiation products occurred in alkylated dinaphthyls of varying degrees of hydrogenation. Mono-alkyl naphthalenes were produced with G = 0.4. The yield of hexyl radicals was estimated to be G = 1.1 and the yield of C_{12} products from their recombination was G = 0.13 at 0.05 mole fraction naphthalene.

RADIOCHEMISTRY AND NUCLEAR CHEMISTRY

REFER ALSO TO CITATION(S) 3784

HOT-ATOM CHEMISTRY

3467 (ORO—3602-20) **Reactions of charged and neutral recoil particles following nuclear transformations. Progress report No. 13.** Ache, H.J. (Virginia Polytechnic Inst. and State Univ., Blacksburg

(USA). Dept. of Chemistry). Sep 1979. Contract EY-76-S-05-3602. 35p. Dep. NTIS, PC A03/MF A01.

Research is reported on: caging and solvent effects in hot ^{38}Cl substitution reactions in chlorinated hydrocarbons (dichlorobenzene), excitation labelling of organic compounds using ^{80}Br, reactions of energetic tritium with graphite and SiC surfaces, and micellar systems and microemulsions studied by positron annihilation. (DLC)

3468 Removal of uranium from aqueous HF solutions. Pulley, H.; Seltzer, S.F. (to Dept. of Energy). US Patent Application 920,525. 29 Jun 1978. 7p.

This invention is a simple and effective method for removing uranium from aqueous HF solutions containing trace quantities of the same. The method comprises contacting the solution with particulate calcium fluoride to form uranium-bearing particulates, permitting the particulates to settle, and separating the solution from the settled particulates. The CaF_2 is selected to have a nitrogen surface area in a selected range and is employed in an amount providing a calcium fluoride/uranium weight ratio in a selected range. As applied to dilute HF solutions containing 120 ppM uranium, the method removes at least 92% of the uranium, without introducing contaminants to the product solution. 1 table.

PROPERTIES OF RADIOACTIVE MATERIALS

REFER ALSO TO CITATION(S) 2675, 2676, 2677

3469 (ANL-CEN-RSD—79-4) **Tables of thermodynamic functions for gaseous thorium, uranium, and plutonium oxides.** Green, D.W. (Argonne National Lab., IL (USA)). Aug 1979. Contract W-31-109-ENG-38. 20p. Dep. NTIS, PC A02/MF A01.

The measured and estimated spectroscopic data for thorium, uranium, and plutonium oxide vapor species have been used with the methods of statistical mechanics to calculate thermodynamic functions.

3470 (GAT—2000) **Use of citric acid for large parts decontamination.** Holland, M.E. (Goodyear Atomic Corp., Piketon, OH (USA)). 12 Sep 1979. Contract EY-76-C-05-0001. 40p. Dep. NTIS, PC A03/MF A01.

Laboratory and field studies have been performed to identify and evaluate chemical decontamination agents to replace ammonium carbonate, an environmentally unacceptable compound, in the decontamination facility for large process equipment at the Portsmouth Gaseous Diffusion Plant. Preliminary screening of over 40 possible decontamination agents on the basis of efficiency, availability, toxicity, cost, corrosiveness, and practicality indicated sodium carbonate and citric acid to be the most promising. Extensive laboratory studies were performed with these two reagents. Corrosion rates, decontamination factors, uranium recovery efficiencies, technetium (^{99}Tc)/ion exchange removal effects, and possible environmental impacts were determined or investigated. Favorable results were found in all areas. Detailed monitoring and analysis during two-week trial periods in which sodium carbonate and citric acid were used in the large parts decontamination facility resulted in similar evaluation and conclusions. Because it has cleaning properties not possessed by sodium carbonate, and because it eliminated several operational problems by incorporating two acidic decontamination reagents (citric and nitric acids) instead of one basic reagent (sodium or ammonium carbonate) and one acidic reagent (nitric acid), citric acid was selected for one-year field testing. On the basis of its excellent performance in the field tests, citric acid is recommended as a permanent replacement for ammonium carbonate in the decontamination facility for large process equipment.

3471 Nonaqueous chemistry of uranium pentafluoride. Halstead, G.W.; Eller, P.G.; Eastman, M.P. (Los Alamos Scientific Lab., NM). *Inorg. Chem.;* **18**: No. 10, 2867-2872(Oct 1979).

Following a report that uranium pentafluoride forms stable solutions in acetonitrile, we have investigated the remarkable behavior of β-UF_5 in a wide variety of coordinating and noncoordinating nonaqueous solvents. Nitriles, dimethyl sulfoxide, and dimethylformamide dissolve up to 0.3 g of UF_5/mL at 25°C to form stable U(V) solutions containing UF_6^- anions and solvated UF_4^+ cations. Salts of the type [UF_4L/sub x/][UF_6] have been isolated from these solutions. Alcohols appear to form metastable solutions of U(V) from which mixed alkoxide-fluorides precipitate. Hydrocarbons, ethers, ketones, and amines are chemically attacked by β-UF_5, whereas fluorocarbons, SO_2, and CS_2 fail to react. A convenient method is also given for producing UF_6^- salts with a variety of cations. Solutions and isolated solids were characterized by elemental analysis and electronic, infrared, Raman, and EPR spectra.

3472 Studies of layered uranium(VI) compounds. I. High proton conductivity in polycrystalline hydrogen uranyl phosphate tetrahydrate. Howe, A.T.; Shilton, M.G. (Univ. of Leeds, England). *J. Solid State Chem.;* **28**: No. 3, 345-361(Jun 1979).

Hydrogen uranyl phosphate tetrahydrate $HUO_2PO_4.4H_2O$ has a high proton conductivity. The ac conductivity was 0.4 ohm^{-1} m^{-1} at 290°K measured parallel to the faces of sintered disks of the compound. The activation energy was found to be 31 +- 3 kJ $mole^{-1}$. The values of conductivity were between 3 and 10 times lower when measured perpendicular to the disk faces due to preferred orientation of the plate-like crystals. Both the powder and sintered disks are stable in air and insoluble in phosphoric acid solution of pH 2.5. Experiments are described which enable possible grain boundary contributions to the conductivity to be determined in such hydrates. The extrinsic grain boundary contribution to the conductivity was found to be small from experiments in which the pH in a solution cell was varied. The abnormally high bulk H^+ conductivity thus inferred is attributed primarily to the high concentration of H^+, which exists as H_3O^+ in the interlamellar hydrogen-bounded network. A Grotthus-type mechanism of conduction is proposed which involves intermolecular transfer steps (hopping) and intramolecular transfer steps, in comparable numbers, the former facilitated by the high concentration of H_3O^+ ions in the structure, and the latter most likely facilitated by the high concentration of H-bond vacancies. 8 figures, 1 table.

3473 Identification of matrix-isolated thorium nitride and the thorium-dinitrogen complex. Green, D.W.; Reedy, G.T. (Argonne National Lab., IL). *J. Mol. Spectrosc.;* 74: 423-434(1979).

The infrared stretching frequencies of $Th^{14}N$ and $Th^{15}N$ in solid Ar and Kr at 14 K have been measured. Multiple sites for the ThN in both matrices were observed; one site for $Th^{14}N$ with anti v = 934.61 +- 0.05 cm^{-1} predominated after the matrix was annealed. For ThN in this site, ω/sub e/ = 941.9 +- 1.0 and ω/sub e/x/sub e/ = 3.7 +- 0.5 cm^{-1}. No dinitride of Th was observed. A thorium-dinitrogen complex was observed with a N-N stretching frequency of 1828.59 +- 0.05 cm^{-1} in solid Ar. The geometry of this complex is C/sub 2v/ with equivalent nitrogen atoms and the bonding approaches that of an ion pair. 4 figures, 4 tables.

RADIOISOTOPE PRODUCTION

REFER ALSO TO CITATION(S) 3631

3474 (ORNL—5581) **Tritium separation from light and heavy water by bipolar electrolysis.** Ramey, D.W.; Petek, M.; Taylor, R.D.; Kobisk, E.H.; Ramey, J.; Sampson, C.A. (Oak Ridge National Lab., TN (USA)). Oct 1979. Contract W-7405-ENG-26. 116p. Dep. NTIS, PC A06/MF A01.

Use of bipolar electrolysis with countercurrent electrolyte flow to separate hydrogen isotopes was investigated for the removal of tritium from light water effluents or from heavy water moderator. Deuterium-tritium and protium-tritium separation factors occurring on a Pd-25% Ag bipolar electrode were measured to be 2.05 to 2.16 and 11.6 to 12.4 respectively, at current densities between 0.21 and 0.50 A cm^{-2}, and at 35 to 90°C. Current densities up to 0.3 A cm^{-2} have been achieved in continuous operation, at 80 to 90°C, without significant gas formation on the bipolar electrodes. From the measured overvoltage at the bipolar electrodes and the electrolyte conductivity the power consumption per stage was calculated to be 3.0 kwh/kg H_2O at 0.2 A cm^{-2} and 5.0 kwh/kg H_2O at 0.5 A cm^{-2} current density, compared to 6.4 and 8.0 kwh/kg H_2O for normal electrolysis. A mathematical model derived for hydrogen isotope separation by bipolar electrolysis, i.e., for a square cascade, accurately describes the results for protium-tritium separation in two laboratory scale, multistage experiments with countercurrent electrolyte flow; the measured tiritum concentration gradient through the cascade agreed with the calculated values.

COMBUSTION, PYROLYSIS, AND HIGH-TEMPERATURE CHEMISTRY

REFER ALSO TO CITATION(S) 2462, 3600

3475 (SAND—79-8713) **Bifurcation phenomena in burner-stabilized premixed flames.** Margolis, S.B. (Sandia Labs., Livermore, CA (USA)). Oct 1979. Contract EY-76-C-04-0789. 47p. Dep. NTIS, PC A03/MF A01.

The one-dimensional stability of an isobaric burner-stabilized premixed flame is investigated for arbitrary Lewis number and stoichiometry in the asymptotic limit of large activation energy. Assuming a one-step irreversible chemical reaction in which fuel and oxidizer react to form a product, a linear stability analysis is used to calculate the neutral stability boundary in Lewis number-activation energy space as a function of incoming flow velocity (or equivalently, the burned temperature). The major result is that although a steady-state adiabatic flame is likely to be stable for typical parameter values, a value of the incoming flow velocity sufficiently less than the adiabatic flame speed is destabilizing to the extent that the unstable region becomes feasible for many flames. Consequently, if

all other parameters are fixed, there exists for such flames a critical value of the incoming flow velocity at which the time-asymptotic solution to the time-dependent problem bifurcates from the unique nontrivial steady state solution. Time-oscillating burner-stabilized flames are observable experimentally, and realistic numerical calculations of a fuel-rich H_2/O_2 premixed flame are presented which further verify the existence of such time-periodic solutions for sufficiently small incoming flow velocities. 10 figures, 1 table.

ENGINEERING

3476 Electropolishing the bore of metal capillary tubes: A technique for adjusting the critical flow. Stoffels, J.J.; Ells, D.R. (Pacific Northwest Laboratory, Richland, Washington 99352). *Rev. Sci. Instrum.;* **50**: No. 12, 1574-1578(Dec 1979).

A technique has been developed for electropolishing the bore of metal capillary tubes. Although developed specifically for stainless-steel tubes, the technique should be directly applicable to other metals. Tubes with inside diameter as small as 0.20 mm and 110 mm long have been successfully electropolished. The electropolishing technique can be used to increase the critical flow of a capillary tube in a controllable way.

FACILITIES AND EQUIPMENT

REFER ALSO TO CITATION(S) 3085, 3266, 3595

3477 (BDX—613-2303) **Mechanical properties of electroplated nickel rings for bath aging study.** Heffley, P.M. (Bendix Corp., Kansas City, MO (USA)). Nov 1979. Contract EY-76-C-04-0613. 17p. Dep. NTIS, PC A02/MF A01.

Hydraulic burst tests were performed on electroplated nickel rings as part of a bath aging study. Ring tensile properties were measured. An invalid failure mechanism was observed for rings having a significant gradient in wall thickness over the height. Finite element method (FEM) stress analysis models established the probable cause and helped set limits for future specimen dimension tolerances.

3478 (COO—4223-5) **Investigation of concept of efficient short wavelength laser. Quarterly progress report, 1 May 1978-31 July 1978.** Piper, L.G.; Krech, R.H.; Pugh, E.R.; Kothandaraman, G.; Taylor, R.L. (Physical Sciences, Inc., Woburn, MA (USA)). 1 Aug 1978. Contract ES-77-C-02-4223. 15p. (PSI-TR—138). Dep. NTIS, PC A02/MF A01.

Emphasis on this program has shifted to the design and construction of two proof-of-concept laser device experiments based on azide chemistry. The laser concepts and the resulting experiments are briefly described in this quarterly report. Preliminary shakedown of the apparatus is now underway. In addition, measurements to provide critical kinetic and spectroscopic data in support of these laser-demonstration experiments have continued at a reduced level of effort. In particular, the solid azide pyrolysis experiment has been reactivated to obtain more quantitative data on branching ratios of certain critical processes. Finally, design and construction has begun on a system to provide 4.9 μ radiation to explore multiphoton dissociation of ClN_3 as an initiation technique.

3479 (GA-A—15442) **Tubing for augmented heat transfer. Final report.** Yampolsky, J.S. (General Atomic Co., San Diego, CA (USA)). Jun 1979. Contract AC05-780R05761. 95p. Dep. NTIS, PC A05/MF A01.

The three areas of investigation covered by the research program are the manufacturing, the heat transfer-fluid flow performance, and the theoretical basis for the performance of spirally fluted tubes. The results of this investigation show that (1) the estimated price of spirally fluted tubing in quantity is equivalent to the cost of present commercially available welded tubing and is considerably lower than that of drawn tubing, and (2) spirally fluted tubing exhibits heat transfer-fluid flow performance advantages over conventional tubing which should lead to tubing cost savings of a factor of two over welded tubing and more for drawn tubing. This implies a lower cost for heat exchange equipment, since a significant part of the cost of this equipment is the cost of the tubing and the remainder of the cost is dependent on the amount of tubing. The dependency is less than linear. Furthermore, a decrease in heat exchanger cost influences plant or system optimizations in the direction that leads to higher efficiencies in product, either in the utilization of raw material in the case of process plants or in the utilization of fuel in the production of power.

3480 (K/D—5015) **Bid evaluation analysis of large power transformers repair vs replacement.** Thomas, R.J. (Union Carbide Corp., Oak Ridge, TN (USA). Nuclear Div.). 28 Sep 1979. Contract W-7405-ENG-26. 12p. Dep. NTIS, PC A02/MF A01.

There are four types of transformer losses that should be considered when evaluating the relative costs of different vendors' transformers. Currents are induced in the iron core of a transformer when it is energized and cause part of the input power to be lost as eddy-currents loss which adds to the hysteresis loss, the sum of which is known as iron loss or no-load loss. Currents that flow through the resistance of the windings produce copper loss. These currents in turn induce flux in adjacent structural iron components of the transformers bracing and containment shell and are referred to as stray flux loss. The combination of copper loss and stray flux loss is called Load Loss. Power used to operate the auxiliary equipment such as fans and pumps is known as cooling loss. The different losses are discussed and tables are given for their evaluation when calculating the cost of repairing or replacing transformers. (TFD)

3481 (SAND—79-8055) **User's manual for Eclipse S-200/230 Digital Data Acquisition System.** Folkendt, S. Jr.; Swan, H.W. (Sandia Labs., Livermore, CA (USA)). Oct 1979. Contract EY-76-C-04-0789. 36p. Dep. NTIS, PC A03/MF A01.

The Eclipse S-200/S-230 Digital Data Acquisition System is a stand-alone data acquisition and reduction center for dynamic mechanical testing. The systems digitally record test data from random vibration, sine sweep, damped sine shock, drop table, and centrifuge, and generate plots immediately on completion of the test on a Tektronix hard copy unit. Plots can be simple time history, visicorder format, power spectral density, cross PSD, transfer functions, coherence, energy spectral density, or shock spectrums. A magnetic tape link with the CDC 6600 is available so that past compatibility can be maintained if desired.

3482 (Y—2188) **Use of laser interferometer for position feedback.** Barkman, W.E. (Oak Ridge Y-12 Plant, TN (USA)). Oct 1979. Contract W-7405-ENG-26. 19p. Dep. NTIS, PC A02/MF A01.

Traditional methods for monitoring the position of machine-tool slides have utilized resolvers, encoders, Inductosyns, etc, that typically infer the position of the cutting tool and part by measuring a secondary characteristic such as the angle of a drive motor or lead screw. Some undesirable features of this technique arise from the lack of rigidity between the point of interest and the point of the measurement. Other disadvantages result from the resolution and accuracy associated with these transducers. The laser interferometer position-measuring systems available today offer +- 0.5 parts-per-million (ppM) accuracy with a maximum measuring velocity of 18m/min (720 in/min) and permit the user to measure more directly the location of the point of interest. The use of laser position-measuring systems on a variety of machine tools is discussed.

3483 miniature stepping motor. Niven, W.A.; Shikany, S.D.; Shira, M.L. (to Dept. of Energy). US Patent Application 957,621. 3 Nov 1978. 9p.

The invention relates to a stepping motor comprising a plurality of stages which may be selectively activated to effect stepping movement of the motor, and which are mounted along a common rotor shaft to achieve considerable reduction in motor size and minimum diameter, whereby sequential activation of the stages results in successive rotor steps with direction being determined by the particular activating sequence followed.

3484 System for testing optical fibers. Golob, J.E.; Looney, J.E.; Lyons, P.E.; Nelson, M.A.; Davies, T.J. (to Dept. of Energy). US Patent Application 954,381. 24 Oct 1978. 15p.

The invention relates to a system for measuring a combination of optical transmission properties of fiber optic waveguides. A polarized light pulse probe is injected into one end of the optical fiber. Reflections from discontinuities within the fiber are unpolarized whereas reflections of the probe pulse incident to its injection remain polarized. The polarized reflections are prevented from reaching a light detector whereas reflections from the discontinuities reaches the detector.

3485 Clamping wrench. Fink, C.F.; Archuleta, J.R. (to Dept. of Energy). US Patent Application 952,877. 18 Oct 1978. 5p.

The wrench comprises two longitudinal members, a main member and a clamping member, which are hinged about a pivot pin in the head of the wrench. The head of each member is cut so that it essentially provides a semicircular wall. These walls, when the wrench is in the closed position, form a circular orifice in the head of the wrench. Through a wall of one of the semicircular cutouts projects a spring loaded ratchet pin, the projecting end of which is beveled so that the wrench will ratchet in one direction. A pin is provided to lock the wrench in closed position and a set screw is utilized to hold the locking pin tight. The wrench may be used as a conventional hand-held wrench but it is sufficiently strong to be used as an impact wrench which can be hit with a sledge hammer. One object of the invention is to solve the problem of tools being dropped down a borehole when a cable is being worked on in position above the hole. Another object of the invention is to

provide a device for tightening portions of a cablehead or downhole instrument together without requiring leveragable elements which project beyond the surface of the cable itself. (TFD)

CRYOGENIC AND SUPERCONDUCTING EQUIPMENT AND DEVICES

REFER ALSO TO CITATION(S) 2968, 3084, 3086, 3087, 3088, 3325, 3511, 3682, 3854, 3917, 3918

3486 (DOE/EV—0046(Vol.2), pp 65-80) **Evaluation of environmental control technologies for magnetic fields.** Keller, W.E. (Los Alamos Scientific Lab., NM). Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

The objectives of this program are: (1) to determine the expected magnetic field strengths, within and beyond the site boundaries, for several nuclear fusion reactors, using magnetic confinement, magnetohydrodynamic (MHD) power generators, superconducting magnets for energy storage (SMES), superconducting transmission lines, magnetically levitated vehicles, and superconducting ac generators; (2) to evaluate the effectiveness of active and passive shielding methods in reducing the field strength; and (3) to gauge the relative cost and cost effectiveness of the shielding method.

3487 (UCRL—83307) **Detection of a normal zone in inductively coupled superconducting coils.** Owen, E.W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Nov 1979. Contract W-7405-ENG-48. 23p. (CONF-791102—3). Dep. NTIS, PC A02/MF A01.

From 8. symposium on engineering problems of fusion research; San Francisco, CA, USA (13 Nov 1979).

A method is described for the electrical detection of a normal zone in inductively coupled superconducting coils. Measurements are made with two kinds of bridges, mutual inductance bridges and self-inductance bridges. The bridge outputs are combined with other measured voltages to form a detector that can be realized with either analog circuits or a computer algorithm. The detection of a normal zone in a pair of coupled coils, each with taps, is discussed in detail. The method also applies to a pair of coils when one has no taps and to a pair when one coil is superconducting and the other is not. The method can be extended, in principle, to a number of coils. A description is given of a technique for balancing the bridges at near the operating currents of the coils.

3488 **Fatigue effects in unidirectional composites: applications to Nb_3Sn superconductors.** Cogan, S.F.; Rose, R.M. (Department of Materials Science and Engineering, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Appl. Phys. Lett.;* **35**: No. 11, 884-886(1 Dec 1979).

A computer-simulated model for the fatigue behavior of multifilamentary unidirectional composites is presented. It is applicable to two-component composites with perfectly elastic filaments in a ductile matrix, and considers both applied cyclic stresses and strains. Information regarding the change in residual stress state, matrix yield strength, and the number of cycles necessary to stabilize properties by the achievement of totally elastic strains (shakedown), or to reach some preassigned failure stress in the matrix, can be determined. Results obtained are applied directly to the fatigue behavior of multifilamentary Nb_3Sn superconducting composites.

3489 **In situ multifilamentary superconducting wires fabricated using a controlled high-temperature gradient.** Fihey, J.L.; Neff, M.; Roberge, R.; Flemings, M.C.; Foner, S.; Schwartz, B.B. (Francis Bitter National Magnet Laboratory and The Plasma Fusion Center, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Appl. Phys. Lett.;* **35**: No. 9, 715-717(1 Nov 1979).

A 0.64-cm-diam. Cu-Nb composite rod was continuously melted at 1800 °C, then resolidified in a controlled large temperature gradient (~ 400 °C/cm) to produce a microstructure of aligned [directionally solidified, (DS)] dendrites in a copper matrix. Primary dendrite arm sizes of ~50, 20, and 10 μm were measured for growth rates of 5.6×10^{-4}, 1.7×10^{-2}, and 0.11 cm/sec, respectively. Higher growth rates produced an equiaxed structure typical of chill casting. After processing, the overall J/sub c/ of the DS wires and the effect of stress on J/sub c/ were comparable to those of chill-cast specimens. The atomic fraction of Nb converted to Nb_3Sn increased with decreasing filament size, and T/sub c/ was approximately 17.6 K for the DS alloys.

3490 **Superconducting wire with improved strain characteristics.** Luhman, T. Klamut, C.J.; Suenaga, M.; Welch, D. (to Dept. of Energy). US Patent Application 966,709. 5 Dec 1978. 9p.

An object of the invention is the production of superconducting wire or tape with improved strain characteristics. A second object is the production of superconducting wire or tape in which the strain produced by the bending of the wire or the application of a tensile force in normal use increases the effective range of critical current carrying capacity. The addition of an unusually small percentage of beryllium, ranging from 0.01 to 0.1 percent by weight, to a low volume, bronze matrix for a superconducting film adds sufficient tensile strength to the matrix to hold the superconducting filament under higher compression upon its formation than has been obtained previously with a similarly sized matrix. The higher compression increases the strain limits and provides a more rugged wire with a higher useful current carrying capacity. (TFD)

PROTECTIVE STRUCTURES AND EQUIPMENT

3491 (FDA—79-8086) **Evaluation of commercially available laser protective eyewear.** Envall, K.R.; Murray, R. Jr. (Bureau of Radiological Health, Rockville, MD (USA)). May 1979. 98p. NTIS.

Forty commercially available laser protective eyewear materials and ten representative frames were evaluated under nonstress and stress conditions by the US Air Force School of Aerospace Medicine (USAFSAM) under an interagency agreement with the Bureau of Radiological Health. Parameters, such as optical density, spectral transmission, luminous transmittance, refractive and prismatic effects, haze, and impact resistance were determined and, where possible, compared to ANSI recommended criteria for occupational eye and face protection. In addition, all materials were subjected to shelf-life, environmental, and laser-induced damage tests to determine damage limits and characteristics. The report, intended for laser users, summarizes the more comprehensive final report submitted by USAFSAM (Technical Report 78-30) and includes testing methodology, experimental apparatus, structural and spectral changes in materials, and guidance in selecting appropriate eyewear.

3492 (NUREG/CR—1055) **Criteria and test methods for certifying air-purifying respirators against radioiodine. Progress report, October 1, 1976-September 30, 1978.** Wood, G.O.; Vogt, G.J.; Gray, D.C.; Kasunic, C.A. (Los Alamos Scientific Lab., NM (USA)). Sep 1979. Contract W-7405-ENG-36. 33p. (LA—8029-PR). Dep. NTIS, PC A03/MF A01.

A project has been initiated to provide a standard test procedure to define the effectiveness of air-purifying respirator cartridges or canisters for airborne radioiodine. The information, procedures, and apparatus designs will provide the means by which air-purifying respirators can be approved for this application. The critical parameters limiting the efficiency and capacity of a given adsorbent cartridge for a given vapor species are: airflow rate, relative humidity, and vapor concentration. Cartridge or canister design parameters such as bed geometry and sorbent used are also critical. A preliminary test system was built. It was used to determine the magnitudes of effects of critical environmental and sorbent bed design parameters on the retention of methyl iodide. Potential radioiodine sorbents were challenged with parts-per-million concentrations of nonradioactive methyl iodide. The resulting breakthrough curves were best described by the equations of the Theory of Statistical Moments. Relative humidity, flow rate, bed diameter, and bed depth had the effects on bed capacity anticipated. However, a concentration effect on capacity was observed that has several implications for respirator cartridge lifetime predictions.

HANDLING EQUIPMENT AND PROCEDURES

3493 (UCRL—52795) **Tritium containment costs at Lawrence Livermore Laboratory.** Shaw, J.F.; Alire, R.M. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 15 Jun 1979. Contract W-7405-ENG-48. 14p. Dep. NTIS, PC A02/MF A01.

Lawrence Livermore Laboratory has improved tritium-handling systems to prevent significant releases of tritium to the environment. Two methods of lowering the costs of such systems have been found: maintaining design flexibility and combining the best features of single- and double-containment designs.

SHIPPING CONTAINERS

3494 (DOE/EV—0046(Vol.2), pp 547-562) **Scale model experiments of energy material shipping containers.** Burian, R.J. (Battelle's Columbus Labs., OH). Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

An ongoing program is being conducted by Battelle's Columbus Laboratories as an integral part of an overall ECT program to overview and assess the adequacy of the public safety and environmental protection provided by containers used in the shipment of spent fuel, high-level wastes, and other DOE energy materials. The efforts of this program are directed toward development of improved techniques for assessment of cask response to specific dynamic impact conditions. Initial phases of the program were directed to verify the applicability of scale modeling techniques utilizing lead shielded/stainless steel cask models. Cask models 1/8, 1/4, and 1/2 linear scale of a typical truck cask were tested. The results indicated that the elastic and plastic response of lead shielded casks can be predicted by tests of replica cask models. Tests conducted to pro-

duce only elastic strains in 1/8- and 1/4-scale models revealed that axial strains at four different locations agree with predictions from scaling theory within 20%; circumferential strains agreed within 40%. For tests of 1/8, 1/4, and 1/2 scale models in which plastic strains were produced, strains generally agreed with scaling theory. These tests also revealed the influence of other conditions such as impact angle, temperature, material properties, and impact target on the response of the cask models. These data are being used by LASL in computer code development for analytically predicting cask response.

TRANSPORT AND STORAGE FACILITIES

REFER ALSO TO CITATION(S) 2456

MINING AND DRILLING EQUIPMENT AND FACILITIES

REFER ALSO TO CITATION(S) 2450

3495 Chemical cutting apparatus and method for use in wells. Chammas, E.D.; Lewis, E.C. II. (to Weatherford/DMC, Inc.). US Patent 4,158,389. 19 Jun 1979. Priority date 18 Apr 1977, United Kingdom of Great Britain and Northern Ireland (UK), 10p.

A chemical cutting apparatus and method for cutting objects in well bores such as, for example, tubing in the bore of an oil or gas well. The apparatus is properly positioned relative to the object to be cut by means of a casing collar locator and an igniter is fired, which in turn activates a gas generator. Pressure from the gas generator axially displaces a slidable piston having one or more wedges pivotally connected thereto. Movement of the piston both pivots and extends the wedge, thereby bringing the wedge into contact with the object to be cut and anchoring the apparatus relative to the object to be cut. The pressure generated in the gas generator is communicated through a passageway in the slidable piston and forces a chemical cutting agent into a chamber containing a reactant. The reaction of the chemical cutting agent and reactant increases the pressure and temperature within the chamber thereby displacing along the axis a second slidable piston. Movement of the second slidable piston exposes radial exhaust orifices thereby allowing the reacting elements in the chamber to escape with great velocity and to contact the object to be cut. 11 claims.

3496 (SAND—79-0522(Vol.5)(No.1), pp 12-17) **Drilling research and development.** Varnado, S.G. May 1979.

In Sandia technology.

A drilling research program has been undertaken in order to reduce the cost of geothermal and fossil fuel drilling and to increase the capability of drilling in hostile environments. The continuous-chain drill bit is being developed for geothermal drilling. A composite diamond bit is being developed for longer bit life and increased penetration rates; gas pressure diffusion bonding was used to attach the composite cutters to the bit body. A pressure coring system was developed. 7 figures. (DLC)

3497 Termination means for a plurality of riser pipes at a floating platform. Brewer, J.H.; Harwood, P.G. (to Compagnie Francaise des Petroles). US Patent 4,142,584. 6 Mar 1979. Filed date 20 Jul 1977. 8p.

A termination means for a plurality of riser pipes at a floating platform including a termination member for supporting said plurality of riser pipes, said termination member being supported and suspended by constant tension means on said platform. The plurality of riser pipes include a central riser pipe and satellite riser pipes arranged around said central riser pipe. Each of the satellite riser pipes extend through the termination member and are supported from said termination member by fluid pressure actuated tension compensator means which serve to tension each of the riser pipes. The termination means is adapted to both rigid and flexible riser pipes. 6 figures, 11 claims.

3498 Modern mining and tunnelling depend on a good combination of compressed air and hydraulic power. Ottosson, L. (Atlas Copco MCT AB, Stockholm, Sweden); Cameron, T.I. pp 29-40 of Fluid power equipment in mining, quarrying, and tunnelling. London, England; Institution of Mechanical Engineers (1974).

From Conference on fluid power equipment in mining quarrying and tunnelling; London, UK (12 Feb 1974).

In developing modern mechanized equipment for mining, tunnelling and quarrying, hydraulic components are used to an increasing extent for positioning feeds, booms, etc. In the paper, examples will be given of these developments. Some examples of actions taken to reduce noise, dust, and vibration from mechanized equipment will also be given.

LASERS

REFER ALSO TO CITATION(S) 3491, 3717

3499 (AD-A—063550) **Noise and the fluctuations and stabilization of power in a CO_2 laser.** Michalski, W.; Nowicki, R.; Plinski, E.F. Translated from *Elektronika ;* **18**: No. 7, 303-305(1977). 14p. NTIS PC A02/MF A01.

No abstract available.

3500 (AD-A—063573) **Description of a high repetition rate tea CO_2 laser installation.** Morency, J.-P. (Defence Research Establishment Valcartier, Courcelette, Quebec (Canada)). Nov 1978. 33p. NTIS PC A03/MF A01.

This document describes a high-repetition-rate TEA-CO_2 laser system which operates in a closed loop and can produce an average output beam power in excess of 1.5 kW at 1 kHz. After a brief outline of the design concepts of this important installation, details are given of the various subsystems involved in the electrical excitation, circulation of gases and control of the optical cavity. Operational characteristics and a description of the behavior of the multimodal beam of radiation are then presented. Despite some limitations due to deterioration of gases and thermally induced distortion of the output coupling window, this laser remains reliable and capable of operating continuously for relatively long periods of time. It is also a versatile tool, incorporating several features which make it safe to use.

3501 Novel CO_2/N_2O waveguide laser. Gerlach, R.; Amer, N.M. (Applied Laser Spectroscopy Group, Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *Rev. Sci. Instrum.;* **50**: No. 12, 1539-1541(Dec 1979).

We present a new design for a waveguide laser which is easily constructed from readily available materials. We have demonstrated its operation for CO_2 (8.5-W output) and N_2O (1.5-W output).

3502 Mechanism of energy decrease in the XeBr laser. Balog, G.; Sander, R.K.; Seegmiller, E. (Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *Appl. Phys. Lett.;* **35**: No. 10, 727-728(15 Nov 1979).

The xenon bromide discharge laser utilizes the reaction of Xe^* with HBr to produce $XeBr^*$ in a dilute mixture with He or Ne buffer gas. XeBr lasers previously reported suffer from a high gas usage rate under static fill conditions. This is caused by the decomposition of HBr in the laser discharge to bromine and hydrogen. This reaction can be reversed using a catalyst in an external gas circulating system. We demonstrate a tenfold reduction in the consumption of the laser mix, namely 126 shots per liter of gas mix for decay of laser energy to 75% of maximum.

3503 Backward Raman compression of XeCl laser pulse in Pb vapor. Djeu, N. (Naval Research Laboratory, Washington, D.C. 20375). *Appl. Phys. Lett.;* **35**: No. 9, 663-665(1 Nov 1979).

Pulse compression has been observed for the spontaneously generated backward Raman wave in Pb vapor pumped by the XeCl laser. A compression factor in excess of 6.7 was observed with a photon efficiency of 42%.

3504 Annular discharge copper vapor laser. Kan, T.; Ball, D.; Schmitt, E.; Hill, J. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). *Appl. Phys. Lett.;* **35**: No. 9, 676-677(1 Nov 1979).

A large-volume high-power copper vapor laser excited by a longitudinal discharge in an annular volume has been demonstrated. The annular geometry provides a device configuration in which the laser prf, governed by a geometric diffusion length, can be made independent of the device volume. Laser powers of 35 W at a prf of 6 kHz has been obtained with an overall device efficiency of 0.44%.

3505 Shifting of infrared radiation using rotational Raman resonances in diatomic molecular gases. Kurnit, N.A. (to Dept. of Energy). US Patent Application 960,409. 13 Nov 1978. 7p.

The invention discloses a device for shifting the frequency of infrared radiation from a CO_2 laser by stimulated Raman scattering in either H_2 or D_2. The device of the preferred embodiment comprises an H_2 Raman laser having dichroic mirrors which are reflective for 16 μm radiation and transmittive for 10 μm, disposed at opposite ends of an interaction cell. The interaction cell contains a diatomic molecular gas, e.g., either H_2 or D_2, and a capillary waveguide disposed within the cell. A liquid nitrogen jacket is provided around the capillary waveguide for the purpose of cooling. In another embodiment the input CO_2 radiation is circularly polarized using a Fresnel rhomb $\lambda/4$ plate and applied to an interaction cell of much longer length for single pass operation.

3506 Multistaged stokes injected Raman capillary waveguide amplifier. Kurnit, N.A. (to Dept. of Energy). US Patent Application 957,630. 3 Nov 1978. 8p.

The invention discloses a multistaged Stokes injected Raman capillary waveguide amplifier for providing a high gain Stokes output signal. The amplifier uses a plurality of optically coupled capillary waveguide amplifiers and one or more regenerative amplifiers to increase Stokes gain to a level sufficient for power amplifica-

tion. Power amplification is provided by a multifocused Raman gain cell or a large diameter capillary waveguide. An external source of CO_2 laser radiation can be injected into each of the capillary waveguide amplifier stages to increase Raman gain. Devices for injecting external sources of CO_2 radiation include: dichroic mirrors, prisms, gratings and Ge Brewster plates. Alternatively, the CO_2 input radiation to the first stage can be coupled and amplified between successive stages.

3507 High power gas laser amplifier. Leland, W.T.; Stratton, T.F. (to Dept. of Energy). US Patent Application 951,543. 13 Oct 1978. 17p.

The invention relates to high energy gas lasers, and more particularly, to a large, high pressure, gas laser power amplifier. The invention provides 100 kJ of focusable optical energy to be delivered to the target in a 1 ns pulse. The peak power of 100 terawatts may be increased for shorter pulses, that is to 200 terawatts for 1/4 ns pulses, without damage to optical components. The laser operates on several rotational lines simultaneously in order to extract energy from the entire rotational manifold during the 1 ns or shorter pulse. (TFD)

3508 High efficiency laser spectrum conditioner. Greiner, N.R. (to Dept. of Energy). US Patent Application 948,375. 4 Oct 1978. 5p.

The invention relates to a high efficiency laser spectrum conditioner for generating a collinear parallel output beam containing a predetermined set of frequencies from a multifrequency laser. A diffraction grating and spherical mirror are used in combination, to disperse the various frequencies along various parallel lines spatially separated from one another to an apertured mask. Selection of the desired frequencies intersect the mask. A recollimated parallel output beam with the desired set of frequencies is accomplished by placement of apertures at locations on the mask where the desired frequencies is subsequently generated utilizing a mirror and grating matched and geometrically aligned in the same manner as the input grating and mirror.

3509 Time delay spectrum conditioner. Greiner, N.R. (to Dept. of Energy). US Patent Application 948,454. 4 Oct 1978. 6p.

A device for delaying specified frequencies of a multiple frequency laser beam. The device separates the multiple frequency beam into a series of spatially separated single frequency beams. The propagation distance of the single frequency beam is subsequently altered to provide the desired delay for each specific frequency. Focusing reflectors can be utilized to prodice a simple but nonadjustable system or, flat reflectors with collimating and focusing optics can be utilized to provide an adjustable system.

3510 Stokes injected Raman capillary waveguide amplifier. Kurnit, N.A. (to Dept. of Energy). US Patent Application 948,267. 3 Oct 1978. 9p.

The present invention overcomes the disadvantages and limitations of the prior art by providing a Stokes injected Raman waveguide amplifier. The device uses an external Stokes signal injected in a capillary waveguide amplifier which Raman scatters CO_2 laser radiation by rotational states of a diatomic molecule such as H_2, D_2, HD, HT, DT or T_2. The Stokes injection signal reduces the required field strength of the CO_2 laser radiation and eliminates the necessity for spontaneous generation of Stokes radiation within the capillary amplifier. It is an object of the invention to provide a Stokes injected Raman capillary waveguide amplifier. It is also an object of the invention to provide a Stokes injected Raman capillary waveguide regenerative amplifier. Another object of the invention is to provide a Stakes injected Raman capillary waveguide amplifier having high output powers.

HEAT TRANSFER AND FLUID FLOW

REFER ALSO TO CITATION(S) 2396, 2970, 3278

3511 (DOE/NASA/0207—79/1) **Flow friction of the turbulent coolant flow in cryogenic porous cables.** Hendricks, R.C.; Yeroshenko, V.M.; Zaichik, L.I.; Yanovsky, L.S. (National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center; Krzhizhanovskij Ehnergeticheskij Inst., Moscow (USSR)). 1979. 19p. (NASA-TM—79052; CONF-790901—2). Dep. NTIS, PC A02/MF A01.

From 15. international congress on refrigeration; Venice, Italy (23 Sep 1979).

Cryogenic power transmission cables with porous cores are considered. Calculations of the turbulent coolant flow with injection or suction through the porous wall are presented within the framework of a two-layer model. Universal velocity profiles have been obtained for the viscous sublayer and flow core. Integrating the velocity profile, the law of flow friction in the pipe with injection was derived for the case when there is a tangential injection velocity component. The effect of tangential velocity on the relative law of flow friction is analysed. The applicability of the Prandtl model to the problem under study is discussed. It is shown that the error due to the acceptance of the model increases with the injection parameter and at lower Reynolds numbers; under these circumstances, the influence of convective terms in the turbulent energy equation on the mechanism of turbulent transport should be taken into account.

3512 Damping solid-flow fluctuations. Klinzing, G.E. (Univ. of Pittsburgh, PA). *Chem. Eng. Sci.;* **34**: No. 7, 971-973(1979).

In the two-phase flow of solids and gases, fluctuations in the solid flow often plague the experimenter or operator. A technique using an expansion volume based on the damping of gas pulsations in one-phase flow is proposed for the two-phase system. The resulting formulation was applied to actual tests on a coal-air flow system and tests show that the damping of the coal-flow fluctuations were achieved, which are in agreement with the theory. This pipe expansion arrangement is suggested as a technique to smooth two-phase flow system operations.

3513 Investigation of the minimum film boiling temperature on horizontal surfaces. Yao, S.; Henry, R.E. (Argonne National Laboratory, Reactor Analysis and Safety Division, Argonne, Ill.). *J. Heat Transfer;* **100**: No. 2, 260-267(May 1978).

The frequency and magnitude of liquid-solid contacts in the film boiling of saturated ethanol and water on horizontal flat stainless steel and copper surfaces are examined with electrical conductance probes. It is observed that, at atmospheric pressure, contacts occur over a wide temperature range and are generally induced by hydrodynamic instabilities. In the ethanol system, these contacts can account for the entire heat transfer rate at the minimum film boiling temperature. The area and duration of contacts are strongly influenced by the dominant nucleation process, and thus depend on the interface temperature and wettability of the solid. At elevated pressures, direct liquid-solid contacts in film boiling are essentially nonexistent for stainless steel and the first major contact corresponds to quenching of the surface. Under these conditions, spontaneous nucleation upon contact seems to be the controlling mechanism for the minimum film boiling temperature. The minimum point appears to be determined either by a Taylor instability vapor removal limitation or by spontaneous nucleation. The governing mechanism is the one which is stable at the lowest wall temperature.

3514 Heat transfer phenomenology of a hydrodynamically unstable melting system. Farhadieh, R.; Baker, L. Jr. *J. Heat Transfer;* **100**: No. 2, 305-310(May 1978).

An experimental study was conducted on a melting system consisting of a liquid layer overlying a solid substrate. The liquid and solid when molten were mutually miscible. To initiate melting, the liquid was heated by a heater grid suspended above the liquid-solid interface. Systems with the density of the liquid less than that of the molten solid were gravitationally stable, whereas those with the density of the liquid greater than that of the molten solid were gravitationally unstable. Total mixing of the melt layer and the liquid layer resulted in thermal mixing of the liquid. The heat transfer coefficient was found to be an increasing function of the density ratio of liquid and melted solid; this increase occurred in four stages. There was a marked enhancement of heat transfer in the system. The melting rate was also found to depend on temperature difference and conduction depth.

MATERIALS TESTING

3515 (ESG-DOE—13280) **Acoustic leak detection-location. Quarterly technical progress report, April-June 1979.** Thiele, A.W. (Rockwell International Corp., Canoga Park, CA (USA). Energy Systems Group). 31 Aug 1979. Contract EY-76-C-03-0824-012. 20p. AT.

Research in developing a multidimensional location system for steam generator tube leaks is reported. Measurements of the acoustic background were made at EBR-2 during flow calibration. The background signals were proportional to flow, but were not dependent upon power level. (FS)

3516 (ORNL/TM—6858) **Computer-aided design of multifrequency eddy-current tests for layered conductors with multiple property variations.** Deeds, W.E.; Dodd, C.V.; Scott, G.W. (Oak Ridge National Lab., TN (USA)). Oct 1979. Contract W-7405-ENG-26. 217p. AT.

Our program is part of a larger project designed to develop multifrequency eddy-current inspection techniques for multilayered conductors with parallel planar boundaries. To reduce the need to specially program each new problem, a family of programs that handle a large class of related problems with only minor editorial and interactive changes were developed. Programs for two types of cylindrical coil probes were developed: the reflection probe, which contains the driver and pickup coils and is used from one side of the specimen, and the through-transmission probe set, which places the driver and pickup coils on opposite sides of the conductor stack. The

programs perform the following basic functions: (1) simulation of an ideal instrument's response to specific conductor and defect configurations, (2) control of an eddy-current instrument interfaced to a minicomputer to acquire and record actual instrument responses to test specimens, (3) construction of complex function expansions to relate instrument response to conductor and defect properties by using measured or computed responses and properties, and (4) simulation of a microcomputer on board the instrument by the interfaced minicomputer to test the analytical programming for the microcomputer. The report contains the basic equations for the computations, the main and subroutine programs, instructions for editorial changes and program execution, analyses of the main programs, file requirements, and other miscellaneous aids for the user.

3517 (UCID—18213) **Portable flash radiography.** Bossi, R.H. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 17 Aug 1979. Contract W-7405-ENG-48. 13p. Dep. NTIS, PC A02/MF A01.

Flash x-ray radiography is now available as a service of the Nondestructive Evaluation Section of the Materials Engineering Division. A variety of experiments can be performed using a number of x-ray head configurations and multiple exposure techniques. Specially trained technicians and engineers can assist in the design of experiments, setup, and testing.

3518 **Ultrasonic signal processor.** Fasching, G.E. (to Dept. of Energy). US Patent Application 949,598. 10 Oct 1978. 13p.

An ultrasonic signal processor is provided which uses an analog integrating circuit in conjunction with a set of digital counters controlled by a precision clock for sampling timing to provide an improved presentation of an ultrasonic transmitter/receiver signal. The signal is sampled relative to the transmitter trigger signal timing at precise times, the selected number of samples are integrated and the integrated samples are transferred and held for recording on a strip chart recorder or converted to digital form for storage. By integrating multiple samples taken at precisely the same time with respect to the trigger for the ultrasonic transmitter, random noise, which is contained in the ultrasonic receiver signal, is reduced relative to the desired useful signal.

ELECTRONIC CIRCUITS AND DEVICES

3519 (BDX—613-2291) **Improved product reliability through the control of moisture.** Gentry, F.L.; Lula, J.W. (Bendix Corp., Kansas City, MO (USA)). Sep 1979. Contract EY-76-C-04-0613. 29p. Dep. NTIS, PC A03/MF A01.

Delamination of multilayer printed wiring boards (PWB) has in the past been a problem of major concern at the Bendix Kansas City Division. The project began with a search for a suitable test to quantitatively measure the interlaminate adhesion of multilayer PWBs. The two methods generally used, peel test and solder float, were eliminated because the peel test cannot be performed at soldering temperatures and the solder float is not quantitative. As an alternative, thermal mechanical analysis was developed as a means to quantitatively measure the delamination resistance of multilayer PWBs.

3520 (BDX—613-2304) **Figure-of-merit for bare and coated wires and flat ribbon jumpers.** Heffley, P.M. (Bendix Corp., Kansas City, MO (USA)). Nov 1979. Contract EY-76-C-04-0613. 15p. Dep. NTIS, PC A02/MF A01.

Wire and ribbon jumpers are often used in HMC's to bridge over other circuitry. A polymeric coating has been proposed for use as a stiffener under high acceleration loads. This work proposes a dimensionless Figure-of-Merit for jumpers and compares bare and coated jumers via classical mathematical models and through a Finite Element Method (FEM) model. Real production geometry, end attachment conditions, and acceleration direction factors are explicitly included in the FEM model. The results do not justify adding the coating.

3521 (BETC/RI—79/4) **Physical properties of gasoline/alcohol blends.** Cox, F.W. (Department of Energy, Bartlesville, OK (USA). Bartlesville Energy Technology Center). Sep 1979. 36p. Dep. NTIS, PC A03/MF A01.

Experimental data were generated for the octane number, water tolerance, micro vapor pressure, and distillation characteristics of gasoline/alcohol blends. The alcohols studied were methanol, ethanol, n-propanol, i-butanol, and two synthetic methyl fuels; each at 5, 10, and 15 wt-pct in two gasolines which had substantially different property values. Each physical property is discussed in reference to value changes brought about by gasoline differences and those brought about by alcohol differences.

3522 (SAND—79-1028) **Power transmission through a nonideal, multilayered piezoelectric device.** Hodgdon, M.L. (Sandia Labs., Albuquerque, NM (USA)). Oct 1979. Contract EY-76-C-04-0789. 23p. Dep. NTIS, PC A02/MF A01.

The document presents solutions to the piezoelectric wave equation with boundary conditions for a one-dimensional multilayered device. The internal losses of the device are considered through the use of constitutive equations that include the time-dependent response of the materials. The constitutive equations were chosen with T and E as dependent variables so that output power could be calculated readily from the transducer geometry and the load. The results are in agreement with experimental data presented herein.

3523 **Grain boundary states and varistor behavior in silicon bicrystals.** Seager, C.H.; Pike, G.E. (Sandia Laboratories, Albuquerque, New Mexico 87185). *Appl. Phys. Lett.;* 35: No. 9, 709-711(1 Nov 1979).

The energy density of states in a Si grain boundary has been quantitatively determined for the first time. Since the deconvolution scheme used in this determination is a technique previously unapplied to real materials, the applicability of the model and the validity of the results were experimentally verified by comparing conductance and capacitance data. Additionally, a high-voltage varistor characteristic (highly non-Ohmic current) was observed. This shows for the first time that a simple grain boundary without intergranular additives is capable of a strong varistor behavior (nonlinearity coefficient $\alpha > 20$).

3524 **Wide-band-gap, alkaline-earth-oxide semiconductor and devices utilizing same.** Abraham, M.M.; Chen, Y.; Kernohan, R.H. (to Dept. of Energy). US Patent Application 973,660. 27 Dec 1978. 16p.

The invention relates to novel and comparatively inexpensive semiconductor devices utilizing semiconducting alkaline-earth-oxide crystals doped with alkali metal. The semiconducting crystals are produced by a simple and relatively inexpensive process. As a specific example, a high-purity lithium-doped MgO crystal is grown by conventional techniques. The crystal then is heated in an oxygen-containing atmosphere to form many $[Li]^0$ defects therein, and the resulting defect-rich hot crystal is promptly quenched to render the defects stable at room temperature and temperatures well above the same. Quenching can be effected conveniently by contacting the hot crystal with room-temperature air.

3525 **Trirotron: triode rotating beam radio-frequency amplifier.** Lebacqz, J.W. (to Dept. of Energy). US Patent Application 963,495. 24 Nov 1978. 10p.

High efficiency amplification of radio frequencies to very high power levels including: establishing a cylindrical cloud of electrons; establishing an electrical field surrounding and coaxial with the electron cloud to bias the electrons to remain in the cloud; establishing a rotating electrical field that surrounds and is coaxial with the steady field, the circular path of the rotating field being one wavelength long, whereby the peak of one phase of the rotating field is used to accelerate electrons in a beam through the bias field in synchronism with the peak of the rotating field so that there is a beam of electrons continuously extracted from the cloud and rotating with the peak; establishing a steady electrical field that surrounds and is coaxial with the rotating field for high-energy radial acceleration of the rotating beam of electrons; and resonating the rotating beams of electrons within a space surrounding the second field, the space being selected to have a phase velocity equal to that of the rotating field to thereby produce a high-power output at the frequency of the rotating field.

3526 **Signal voter.** Goodwin, R.L. (to Dept. of Energy). US Patent Application 957,633. 3 Nov 1978. 10p.

The invention discloses a voter for providing a single accurate output signal that is derived from the closest two signal levels of three input signals, each of which signals represents a measurement of the same phenomena. By means of the voting circuit, the signals are first sorted by level of amplitude and then ranked as highest, middle or lowest. The highest or lowest signal that is furthest from the middle signal is rejected, while the other highest or lowest signal is selected for processing. The selected high or low signal is then averaged with the middle signal to provide the output signal.

WASTE PROCESSING PLANTS AND EQUIPMENT

3527 **Initial study: X-50 pyrolysis system, Port of Redwood City, Redwood City, California.** San Rafael, CA; Madrone Associates (1979). 57p. (NP—24072).

Pyro-Sol, Incorporated has proposed the construction and operation of an X-50 Pyrolysis System at the Port of Redwood City. This resource recovery system takes existing shredded scrap material, subjects it to indirect heat at reduced pressures under a reducing atmosphere, and through a process of destructive distillation, breaks

down the organic and inorganic compounds of the scrap material into water, inert residues, and a mixture of gases. Roughly one-third of the produced gas is used to fire the pyrolysis process; the remainder is used to generate electricity. The physical features of the plant are described. The quantity and nature of the solid waste materials to be used, i.e., both scrapped automobile parts and municipal waste, are discussed. The environmental impacts of the pyrolysis plant on soils, air, water, noise, and ecosystems near the site and the net energy available from the process are estimated. (LCL)

COMBUSTION SYSTEMS

REFER ALSO TO CITATION(S) 2392, 2396, 2432, 2464, 2465, 2467, 3191

3528 (FE—2452-28) **Hot corrosion/erosion testing of materials for application to advanced power conversion systems using coal-derived fuels. Task II. Fluidized bed combustion. Second task report, January 1-July 1, 1978.** Bertrand, R.R.; Ernst, M.; Hoke, R.C.; Loughnane, M.D.; Nutkis, M.S.; Siminski, V.J. (Exxon Research and Engineering Co., Linden, NJ (USA). Government Research Lab.). Sep 1978. Contract EX-76-C-01-2452. 106p. Dep. NTIS, PC A06/MF A01.

The first portion of a 1000 hour exposure test of potential gas turbine and boiler tube materials suitable for use in Pressurized Fluidized Bed Coal Combustion (PFBC) was successfully completed. A 250 hour test was carried out in the Exxon PFBC Miniplant under realistic test conditions. The run was interrupted for one six hour period. Flue gas temperatures downstream of the combustor were maintained at 1550°F or higher. Gas turbine and boiler tube specimens showed no obvious signs of damage after the 250 hour test. The gas turbine specimens showed some signs of deposition, but the deposits were easily removed by brushing.

3529 **Method of regulating the amount of underfire air for combustion of wood fuels in spreader-stoker boilers.** Tuttle, K.L. (to Dept. of Energy). US Patent Application 966,523. 4 Dec 1978. 7p.

A method of metering underfire air for increasing efficiency and reducing particulate emissions from wood-fire, spreader-stoker boilers is disclosed. A portion of the combustion air, approximately one pound of air per pound of wood, is fed through the grate into the fuel bed, while the remainder of the combustion air is distributed above the fuel in the furnace, and the fuel bed is maintained at a depth sufficient to consume all oxygen admitted under fire and to insure a continuous layer of fresh fuel thereover to entrap charred particles inside the fuel bed.

UNDERGROUND ENGINEERING

REFER ALSO TO CITATION(S) 3496

MARINE ENGINEERING

3530 **Offshore platforms.** Martin, Y. (to Compagnie Francaise d'Entreprises Metalliques). US Patent 4,155,674. 22 May 1979. Priority date 17 Aug 1976, France, 4p.

An offshore platform of the weighted base kind has a castellated contour at the base of the skirts, the shape of the contour being such as to produce, at the first impact with the ground, a contact line appreciably shorter than the average length of the contour.

3531 **Floating structure.** Yashima, N. (to Mitsui Engineering and Shipbuilding). US Patent 4,155,673. 22 May 1979. Filed date 26 May 1977. 6p.

The invention relates to a floating structure, e.g. an offshore platform adapted for use in exploitation of submerged oil fields and the like purposes at offshore areas. The structure has a platform from which extended downwardly are columns carried by footings having buoyancy large enough to keep the platform afloat. Tension wires are extended through the footings for connection to the sea bottom in a diverging manner. Sinkers are provided at intermediate portions of respective tension wires so that the portions of the laters between the sea bottom and the points at which the sinkers are provided may exhibit sags. The sagged portions of the tension wires are expected to present a buffering effect to diminish the extraordinary large tension in the tension wires attributable to the movement of the platform. The up and downward movement of the platform is prevented by a riser pipe extended from the center of the platform. The riser pipe is prevented from being buckled by a provision of a buoyancy body attached thereto.

POLLUTION CONTROL EQUIPMENT

REFER ALSO TO CITATION(S) 3596, 3614

3532 (NTIS/PS—79/0266) **Gas scrubbers used in pollution control. Volume 2. 1976-March, 1979 (citations from the NTIS data base). Report for 1976-March 1979.** Cavagnaro, D.M. (National Technical Information Service, Springfield, VA (USA)). Apr 1979. 310p. NTIS PC N01/MF N01.

The cited Federally-funded research reports cover processes and equipment used in the removal of SO_2, NO/sub x/, CO, CO_2, organic compounds, and particulates. Design, performance, chemistry, and some of the gas flow characteristics for both stationary as well as mobile sources are included. (This updated bibliography contains 301 abstracts, 118 of which are new entries to the previous edition.)

3533 (NTIS/PS—79/0267) **Gas scrubbers used in pollution control. Volume 4. 1977-March, 1979 (citations from the Engineering Index data base). Report for 1977-March 1979.** Cavagnaro, D.M. (National Technical Information Service, Springfield, VA (USA)). Apr 1979. 172p. NTIS PC N01/MF N01.

The citations from a worldwide literature survey relate to particle and gas scrubbers. The reports discuss design, performance, gas flow characteristics, and chemistry of the pollutants. Pollution control of SO_2, NO/sub x/, CO, CO_2, hydrocarbons, and particles is considered. (This updated bibliography contains 165 abstracts, 17 of which are new entries to the previous edition.)

3534 (NTIS/PS—79/0268) **Gas scrubbers used in pollution control (citations from the American Petroleum Institute). Report for 1976-January 1979.** Cavagnaro, D.M. (National Technical Information Service, Springfield, VA (USA)). Apr 1979. 209p. NTIS PC N01/MF N01.

This bibliography contains citations on particle and gas scrubbers as they are used to control NO/sub x/, CO, CO_2, SO_2, hydrocarbons, and particles. The reports cover performance design, gas flow characteristics, and process chemistry. (Contains 203 abstracts)

PARTICLE ACCELERATORS

DESIGN, DEVELOPMENT, AND OPERATION

3535 **ISABELLE.** Schewe, P.; Wanderer, P. (American Institute of Physics, 335 East 45th St., New York, N.Y. 10017). *Phys. Teach.;* **17**: No. 7, 425-436(Oct 1979).

The physics that will be possible at Brookhaven National Laboratory ISABELLE is reviewed in basic terms. Among the topics discussed are gluons, intermediate vector bosons, jets, and total cross sections.(AIP)

BEAM DYNAMICS, FIELD CALCULATIONS, AND ION OPTICS

REFER ALSO TO CITATION(S) 3547

3536 (BNL—26780) **Ion source and transport system for BNL-HIF pre-accelerator.** Gammel, G.M.; Meier, E.F.; Mobley, R.M. (Brookhaven National Lab., Upton, NY (USA)). 1979. Contract EY-76-C-02-0016. 4p. (CONF-790927—29). Dep. NTIS, PC A02/MF A01.

From Linear accelerator conference; Montauk, NY, USA (10 Sep 1979).

The operating characteristics of the ion source and of an initial model transport system developed by the Heavy Ion Fusion group at BNL will be presented. The purpose of the assembly was to transport a 30 mA beam of heavy ions a few feet inside a small, inexpensive Cockcroft-Walton at the source voltage ($\leqq$ 50 kV) to a single 3" diameter high voltage gap ($\leqq$ 500 kV). This isolation of the gap from the source prevented high voltage breakdown due to gas loading from the source. After the gap, the beam was to be matched into a 2 MHz electrostatic quadrupole linac which would in turn be the first stage of a heavy ion fusion accelerator.

3537 (LBL—9741) **Study of microwave instabilities by means of a squarre-well potential.** Kim, K.J. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Sep 1979. Contract W-7405-ENG-48. 17p. Dep. NTIS, PC A02/MF A01.

Microwave instabilities are analyzed in a simple model in which the usual synchroton oscillation of a particle is replaced by particle motion in a square well potential. In this way the previous

difficulties in the theory complexity disappear. The model is precisely defined, solved, and the properties of the solution are discussed. 5 references. (JFP)

3538 Calculations pertaining to the design of a prebuncher for an electron linear accelerator. Alsmiller, R.G. Jr.; Alsmiller, F.S.; Barish, J.; Lewis, T.A. (Oak Ridge National Lab., TN (USA)). *Part. Accel.;* **9**: No. 3, 187-200(Mar 1979).

Results derived from calculations based on a one-dimensional ballistic model are presented to indicate the extent to which a current pulse of 150-keV electrons containing 1 μC of charge and having a duration of 15 nsec (FWHM) can be bunched or compressed into a single smaller pulse by a combination of accelerating and decelerating voltage gaps followed by a drift space. To be useful, the bunched current must be accelerated by an existing accelerator (ORELA), so the calculated results include estimates (upper and lower limits) of the fraction of the bunched beam that will be accelerated. It is found that with 8 voltage gaps the 15-nsec (FWHM) pulse can be reduced to a pulse of approximately 4 nsec (FWHM) in a length approximately 400 cm and that approximately 50% of this bunched pulse will be accelerated by ORELA. The fraction of the bunched pulse that will be accelerated is approximately the same as that for an unbunched pulse.

3539 Longitudinal motion of singly charged uranium ions at 9.5 GeV. Neil, V.K.; Buchanan, H.L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). *Part. Accel.;* **9**: No. 3, 207-212(Mar 1979).

This work describes a computer code that can be used to study the non-relativistic motion of heavy ions in longitudinal phase space. A distribution function is employed and the longitudinal electric self-field is included in an approximate fashion. The code is used to study the longitudinal compression of a pulse containing 50 μC of singly-charged uranium ions at 9.5 GeV. Results indicate that an initial pulse duration of 70 nsec can be reduced to 15 nsec in a distance of 600 m. The compression is achieved by applying a rather modest (approximately 500 kV/m) time-varying longitudinal electric field over the first 500 m.

AUXILIARIES AND COMPONENTS

ION SOURCES

3540 (LBL—9619) **Recent progress in ion sources and preaccelerators.** Clark, D.J. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Sep 1979. Contract W-7405-ENG-48. 12p. (CONF-790927—30). Dep. NTIS, PC A02/MF A01.

From Linear accelerator conference; Montauk, NY, USA (10 Sep 1979).

Recent progress in ion sources is reviewed. The types of sources discussed include positive and negative proton and deuteron sources developed for conventional preaccelerators and for neutral beam applications. Positive heavy ion sources for conventional linacs and for induction linacs are included. Negative heavy ion sources are used for tandem electrostatic accelerators. Positive and negative polarized ion sources for protons and deuterons inject cyclotrons, tandems, and linacs. Some recent preaccelerator designs are summarized.

EXPERIMENTAL FACILITIES AND EQUIPMENT

REFER ALSO TO CITATION(S) 3552, 3556, 3584

3541 (GEPP-OP—464) **Application of thermal desorption analysis to material compatibility.** Mehrhoff, T.K. (General Electric Co., St. Petersburg, FL (USA). Neutron Devices Dept.). 1979. Contract EY-76-C-04-0656. 16p. Dep. NTIS, PC A02/MF A01.

Shelf life of neutron generators is concerned mainly with the maintenance of a good vacuum within the tube envelope. Frequently, gas-metal interactions can cause a malfunction within the tube. This paper deals mainly with gas-metal interactions that have been characterized using thermal desorption analysis techniques.

3542 (LA—7895) **Microprocessor-based stepping motor driver.** Halbig, J.K.; Klosterbuer, S.F. (Los Alamos Scientific Lab., NM (USA)). Sep 1979. Contract W-7405-ENG-36. 26p. Dep. NTIS, PC A03/MF A01.

The Pion Generation for Medical Irradiations (PIGMI) program at the Los Alamos Scientific Laboratory requires a versatile stepping motor driver to do beam diagnostic measurements. A driver controlled by a microprocessor that can move eight stepping motors simultaneously was designed. The driver can monitor and respond to clockwise- and counterclockwise-limit switches, and it can monitor a 0- to 10-V dc position signal. The software controls start and stop ramping and maximum stepping rates. 2 figures, 1 table.

3543 (SLAC-PUB—2380) **Rf sources developments.** Lebacqz, J.V. (Stanford Linear Accelerator Center, CA (USA)). Aug 1979. Contract EY-76-C-03-0515. 9p. (CONF-790927—24). Dep. NTIS, PC A02/MF A01.

From Linear accelerator conference; Montauk, NY, USA (10 Sep 1979).

The continuing need for accelerators of increasingly sophisticated characteristics requires a great variety of rf sources to provide the energy used by these accelerators. The present status of gridded tubes will be reviewed briefly. Klystrons, which are used in most large accelerators, will be considered in some detail. Their limitations in power and frequency will be reviewed and a study of their reliability will be presented. Improvements in their efficiency will be discussed, and trends for the future will be considered. Some limitations caused by material problems will become evident and a review of some of the potential improvements in that area will be considered. Finally, new types of rf sources based on rotating electron beams which are now in the development stage will be described and compared to existing tube types.

3544 Target assembly. Lewis, R.A. (to Dept. of Energy). US Patent Application 958,863. 8 Nov 1978. 7p.

According to the present invention, a linear accelerator capable of producing a high power, high current proton beam and a state of the art breeding blanket are coupled by a target for the proton beam consisting of a plurality of solid pins formed of a neutron emissive target material disposed parallel to the path of the beam and arranged axially in a plurality of layers so that pins in each layer are offset with respect to pins in all other layers, enough layers being used so that each proton in the beam will strike at least one pin with means being provided to cool the pins. For a 300 mA, 1 GeV beam (300 MW), stainless steel pins, 12 inches long and 0.23 inches in diameter are arranged in triangular array in six layers with one sixth of the pins in each layer, the number of pins being such that the entire cross sectional area of the beam is covered by the pins with minimum overlap of pins.

3545 Memorial Sloan-Kettering biomedical cyclotron facility: program overview. Tilbury, R.S. (Memorial Sloan-Kettering Cancer Center, New York, NY). *Prog. Nucl. Med.;* **4**: 2-5(1978).

An overview of the Sloan-Kettering cyclotron facility is presented, and comments are made about the funding of biomedical cyclotrons, in general. (GHT)

3546 Memorial Sloan-Kettering biomedical cyclotron facility: radioisotope production and labeled compounds. Tilbury, R.S. (Memorial Sloan-Kettering Cancer Center, New York, NY). *Prog. Nucl. Med.;* **4**: 100-107(1978).

This is a brief review of the yields of radioisotopes that have been achieved with the CS-15 cyclotron, both in comparison with the CS-30 machine and also perhaps with the BLIP and LAMPF programs.

STORAGE RINGS

REFER ALSO TO CITATION(S) 3535, 3537

3547 (BNL—26691) **Two stream instability in electron storage rings.** Irani, A.A. (Brookhaven National Lab., Upton, NY (USA)). 17 Aug 1979. Contract EY-76-C-02-0016. 4p. Dep. NTIS, PC A02/MF A01.

Electron bunches in storage rings can ionize the background gas and depending on the bunch length and spacing between bunches the ions formed can be trapped by the electron space charge forces. It is the purpose of this note to show that the possibility of exciting the two stream instability then exists. This instability if excited would saturate by giving thermal velocity to the electrons i.e., by blowing up the emittance of the beam. Experiments carried out at ADONE have observed an increase in the electron beam emittance in the presence of background ions.

INSTRUMENTATION

REFER ALSO TO CITATION(S) 3463

RADIATION INSTRUMENTATION

GENERAL DETECTORS AND MONITORS

REFER ALSO TO CITATION(S) 3017

3548 (COO—1671-79) **Theory of RBE. Fourth triennial report, 1 January 1967-31 December 1978.** Katz, R. (Nebraska Univ., Lincoln (USA). Dept. of Physics). Sep 1978. Contract EY-76-S-02-1671. 15p. Dep. NTIS, PC A02/MF A01.

From a single set of themes, the Theory of RBE has developed a picture of the response of many detectors to radiations of different quality. Formulas of the theory and a set of experimental parameters for each detector lead to predictions of detector response to different radiation fields, which serve also as a test of the theory. We have predicted that detector response is not a single valued function of LET or REL. We have invented a characteristic parameter kappa, combining both radiosensitivity and sensitive element size, in a way suitable for describing detector response as a function of z^{*2}/β^2 of monoenergetic incident particles, and encompassing the transition from grain-count to track-width regimes, the variation of OER and RBE with LET as well. We have emphasized the importance of delta-rays in track structure, and have shown that it is this which is responsible for the multiple valuedness of response with LET and even with z^{*2}/β^2. We have predicted that quality factors are misleading, that one cannot combine high and low LET response linearly to find the response to a mixed environment, and have shown how we can predict biological response in complex radiation environments, such as neutrons, pions, or heavy ions, contaminated with electrons and gamma-rays, and spread by a ridge filter. We have sought to identify the basic aspects of detector response which lead biological substances to exhibit a RBE greater than 1 with high LET radiations, and have used that result to discover physical detectors having that property. Currently, studies of these detectors (supralinear emulsions and TLD's) are being made to find the extent to which their properties can be adjusted to mimic the response of biological cells and tissues to radiation fields of different quality, and to use them as testing grounds for models of radiation action.

3549 (HEDL-SA—1804) **Proton and alpha particle response characteristics of CR-39 polymer for reactor and dosimetry applications.** Preston, C.C.; Gold, R.; Ruddy, F.H. (San Francisco Univ., CA (USA); Hanford Engineering Development Lab., Richland, WA (USA); Macalester Coll., Saint Paul, MN (USA)). 1979. Contract EY-76-C-14-2170. 14p. (CONF-790765—1). Dep. NTIS, PC A02/MF A01.

From 10. international conference on solid state nuclear track detectors; Lyons, France (2 Jul 1979).

Proton and alpha particle response characteristics of CR-39 polymer for reactor and dosimetry applications have been investigated. The investigation included measurement of track etch rate as a function of proton and alpha particle energy. A calibration curve of track diameter versus proton energy is presented. The promising capabilities for reactor proton spectrometry and passive fast-neutron personnel dosimetry techniques are discussed.

3550 (HEDL-SA—1806) **Applications of solid state track recorders in United States Nuclear Reactor Energy Programs.** Gold, R.; Ruddy, F.H.; Roberts, J.H. (Hanford Engineering Development Lab., Richland, WA (USA)). Jun 1979. Contract EY-76-C-14-2170. 16p. (CONF-790765—2). Dep. NTIS, PC A02/MF A01.

From 10. international conference on solid state nuclear track detectors; Lyons, France (2 Jul 1979).

Portions of document are illegible.

The domain of Solid State Track Recorder (SSTR) applications in United States nuclear reactor energy programs extends from the harsh high temperature environments found in high power reactor cores to very low flux environments arising in out-of-core locations, critical assemblies, or away from reactors (AFR) experiments. The neutron energy region arising in these applications is very broad, covering more than eight decades from thermal up to fusion energies. The range of neutron flux/fluence intensity is even greater, extending over more than thirteen decades. As a consequence, use of a variety of SSTR is entailed in US Fast Breeder Reactor (FBR), Light Water Reactor (LWR), and Magnetic Fusion Energy Reactor (MFER) programs. A summary status is presented of selected SSTR experiments undertaken in these programs at the Hanford Engineering Development Laboratory (HEDL).

3551 (ORO—5933-T1) **Zero cross over timing with coaxial Ge(Li) detectors.** El-Ibiary, M.Y. (Oklahoma Univ., Norman (USA)). Jul 1979. Contract ER-78-S-05-5933. 55p. Dep. NTIS, PC A04/MF A01.

The performance of zero cross over timing systems of the constant fraction or amplitude rise time compensated type using coaxial Ge(Li) detectors is analyzed with special attention to conditions that compromise their energy-independence advantage. The outcome is verified against existing experimental results, and the parameters that lead to minimum disperson, as well as the value of the dispersion to be expected, are given by a series of charts.

RADIATION DOSEMETERS

REFER ALSO TO CITATION(S) 3548

NUCLEAR SPECTROSCOPIC INSTRUMENTATION

3552 (CONF-790875—1) **Argonne pulsed neutron source program.** Carpenter, J.M.; Crawford, R.K.; Peterson, S.W.; Mueller, M.H.; Jorgensen, J.D.; Reis, A.H. Jr. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 20p. Dep. NTIS, PC A02/MF A01.

From Conference on diffraction profile analysis and open meeting of the commission on neutron diffraction; Cracow, Poland (14 Aug 1979).

The development of the pulsed spallation neutron source and the associated experimental facility is described. The neutron scattering instrumentation includes several diffractometers and spectrometers.

RADIOMETRIC INSTRUMENTS

REFER ALSO TO CITATION(S) 3016

MISCELLANEOUS INSTRUMENTS

REFER ALSO TO CITATION(S) 2783, 2944, 3032, 3515

3553 (DP—1534) **Pulse height analyzer/oscilloscope display interface.** Woodward, W.J. Jr. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). Oct 1979. Contract EY-76-C-09-0001. 14p. Dep. NTIS, PC A02/MF A01.

A portable interfacing instrument was developed that accepts digital information from a pulse height analyzer and displays it as an energy spectrum on an ordinary laboratory oscilloscope.

3554 (ENICO—1014) **Ultrasonic liquid-in-line detectors: development, evaluation, and implementation.** Piper, T.C. (Exxon Nuclear Idaho Co., Inc., Idaho Falls (USA)). Oct 1979. Contract AC07-79IDO1675. 22p. Dep. NTIS, PC A02/MF A01.

Ultrasonic liquid-in-line sensors designed and fabricated of 1/4 in. and smaller diameter tubing are discussed and evaluated. Problems of impedance matching and acoustic reflection are considered. Tone-burst excitation of piezoelectric crystals is found to be useful in producing sensors that behave predictably. 6 figures.

3555 (LBL—9276) **CAMAC system for computer control of microwave spectrometers.** Zizka, G.; Turko, B.; Kolbe, B. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). 1 Jun 1979. Contract W-7405-ENG-48. 20p. Dep. NTIS, PC A02/MF A01.

An interface between a microwave spectrometer and a computer is described. It consists of three CAMAC modules and uses a standard CAMAC crate and controller. The hardware, in conjunction with appropriate software routines was designed to synchronize measurements, to collect data, and to control the microwave frequency and other experimental parameters.

3556 (LBL—9904) **Microchannel plate based detector for a heavy ion beam spectrometer.** Green, M.I. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Oct 1979. Contract W-7405-ENG-48. 5p. Dep. NTIS, PC A02/MF A01.

The design parameters and operating characteristics of the detector used in the Brutus and Fannie heavy ion beam spectrometers at the SuperHILAC facility are described. The detector utilizes a 25 mm diameter microchannel plate array to obtain gains of 10^2 to 10^8 with a linear dynamic range of 10^3. It has had over three years of almost maintenance-free service, detecting ion beams from carbon to xenon with energies between 1.2 and 8.5 MeV per nucleon.

3557 (SAND—79-8057) **Precision volume measurement system.** Jones, R.L. (Sandia Labs., Albuquerque, NM (USA)). Oct 1979. Contract EY-76-C-04-0789. 32p. Dep. NTIS, PC A03/MF A01.

A precision volume measurement system (PVMS) has been designed, built, and put into operation. The system is based on pressure-volume-temperature principles, uses helium as the source gas, and maintains temperature stability in a calorimeter bath. The accuracy/precision of the system varies with the size of the measured volume; however, typical readings for a 100-cm^3 volume show a precision of approximately 0.03% and an accuracy of approximately 0.05%.

3558 (UCRL—15096) **Shock temperatures in metals. Final report, March 29, 1977-September 30, 1978.** Ahrens, T.J.; Lyzenga, G.A. (California Inst. of Tech., Pasadena (USA)). 1978. Contract W-7405-ENG-48. 19p. Dep. NTIS, PC A02/MF A01.

A system for measurement of the spectral radiace of materials shocked to high pressures ($\sim$ 100 GPa) by impact using a light-gas gun is described. Thermal radiation from the sample is sampled at six wavelength bands in the visible spectrum, and each signal is separately detected by solid state photodiodes and recorded with a time resolution of $\sim$ 10 ns. Interpretation of the records in terms of temperature of transparent sample materials is discussed. Results of a

series of exploratory experiments with metals are also given. Shock temperatures in the range 4000°K to 8000°K have been reliable measured. Spectral radiance and temperatures have been determined with uncertainties of 2%.

3559 (UCRL—81669) **Transducer Field Test Set.** Miller, T.B.; Freynik, H.S. Jr. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 2 Aug 1979. Contract W-7405-ENG-48. 14p. (CONF-790635—4). Dep. NTIS, PC A02/MF A01.

From 10. transducer workshop; Colorado Springs, CO, USA (12 Jun 1979).

The Transducer Field Test Set is a unique multifunction instrument designed primarily for use with strain-gage-based transducers. The test set incorporates into one portable unit many of the individual instruments and functions required to install, check out, calibrate, troubleshoot, and measure data from transducers at sites away from the transducer laboratory. This unit eliminates the necessity for locating, collecting, and transporting the necessary separate components each time a test is fielded. The operation of the Field Test Set (FTS-1) and the tasks it is able to perform are described. Improvements to be incorporated into the second generation design (FTS-2) are discussed.

3560 **X-ray filter assembly for fluorescence measurements of x-ray absorption fine structure.** Stern, E.A.; Heald, S.M. (Physics Department, University of Washington, Seattle, Washington 98195). *Rev. Sci. Instrum.;* **50**: No. 12, 1579-1582(Dec 1979).

Fluorescence detection, in principle, permits the detection of the extended x-ray absorption fine structure (EXAFS) of more dilute atoms than can be obtained in absorption. To take advantage of this it is necessary, in practice, to eliminate the background that normally accompanies the fluorescence signal. We describe an x-ray filter assembly that accomplishes this purpose. The unique characteristic of the assembly is a slit system that minimizes the fluorescence background from the filter. The theory of the slit assembly is presented and is found to agree with measurements made on the Fe EXAFS of a dilute sample. The filter assembly has a better effective counting rate in this case than that of a crystal monochromator design.

3561 **Simple pressure gauge for uranium hexafluoride.** George, P.M.; Swanson, M.N.; Beauchamp, J.L. (Arthur Amos Noyes Laboratory of Chemical Physics, California Institute of Technology, Pasadena, California 91125). *Rev. Sci. Instrum.;* **50**: No. 12, 1640-1644(Dec 1979).

A sensitive detector and pressure gauge for uranium hexafluoride in high-vacuum systems is described. Negative surface ionization of UF_6 occurs on ribbon filaments operated at temperatures too low for electron emission to be significant. The ion current measured on a cylindrical collector surrounding the filament assembly varies regularly with UF_6 pressure below 10^{-3} Torr. Different filament materials are considered, including rhenium, thoriated tungsten, and platinum. Rhenium is found to be the most satisfactory material for operation of diode emitters as a pressure gauge. Gauge constants (in A $Torr^{-1}$) are derived from comparing negative surface ionization currents with the response of a capacitance manometer and are shown to be independent of temperature within a reasonable operating range. The effects of exposing the rhenium filament to various gases is considered, and it is shown that brief exposure to acetylene substantially improves the operating characteristics of the gauge.

3562 **Streak camera-TV system with improved S/N ratio incorporating a digital video recorder directly interfaced to a computer.** Schmidt, K.H.; Gordon, S. (Chemistry Division, Argonne National Laboratory, Argonne, Illinois 60439). *Rev. Sci. Instrum.;* **50**: No. 12, 1656-1657(Dec 1979).

By incorporating a digital video recorder, a streak camera system previously developed for recording time-resolved transient absorption and emission spectra was greatly improved with respect to reproducibility and accuracy. The requirements for on-line computer time were also reduced.

3563 **Broadly tunable picosecond infrared source.** Campillo, A.J.; Hyer, R.C.; Shapiro, S.L. (Los Alamos Scientific Laboratory, University of California, P.O. Box 1663, Los Alamos, New Mexico 87545). *Opt. Lett.;* **4**: No. 10, 325-327(Oct 1979).

We report a completely grating tuned (1.9—2.4 μm) picosecond traveling-wave infrared generator capable of controlled spectral-bandwidth operation down to the Fourier-transform limit. Subsequent down-conversion in CdSe extends the tuning range to 10—20 μm.

3564 **Notes on linear image restoration by maximizing the a posteriori probability.** Trussell, H.J. (Univ. of California, Los Alamos, NM). *IEEE Trans. Acoust., Speech, Signal Process.;* **26**: No. 2, 174-176(Apr 1978).

A distinction is made between the minimum mean-square error estimate derived for the linear case of maximum a posteriori restoration and the common Wiener estimate. The linear MAP filter is shown to produce good results with less a priori knowledge than is required for the Wiener filter.

WELL LOGGING INSTRUMENTATION

3565 **Pulsed neutron well logging apparatus having means for determining background radiation.** Randall, R.R. (to Dresser Industries, Inc.). US Patent 4,157,469. 5 Jun 1979. Filed date 2 Nov 1977. 8p.

A neutron generator in a well logging instrument is periodically pulsed and has an off period between pulses of 1000 microseconds. A neutron detector is gated on at intervals of 400 to 500, 550 to 650, and 700 to 800 microseconds, respectively, following the termination of each burst of fast neutrons. Circuitry is provided for determining the background radiation and for determining the macroscopic absorption. 3 claims.

EXPLOSIONS AND EXPLOSIVES

CHEMICAL

3566 (LA—7819) **Steady-wave analysis of the effect of porosity on viscous and inviscid detonations by use of a reactive-porous analog.** Rabie, R.L. (Los Alamos Scientific Lab., NM (USA)). Sep 1979. Contract W-7405-ENG-36. 29p. Dep. NTIS, PC A03/MF A01.

A simple two-rate reactive material analog is used to determine reactive flow in a slightly porous medium. The rates govern the evolution of a chemical reaction coordinate and a solid volume coordinate, respectively. The rates are coupled so that mechanical phenomena can affect chemical phenomena and vice versa. Steady waves in both viscous and inviscid flow have been examined, with variations in ignition criteria being of prime interest in the viscous flow. A particular result is that the steady-state detonation velocity depends upon the ignition conditions.

3567 (LA—7869) **Mach stems formed by colliding cylindrical detonation waves.** Mader, C.L.; Venable, D. (Los Alamos Scientific Lab., NM (USA)). Sep 1979. Contract W-7405-ENG-36. 21p. Dep. NTIS, PC A02/MF A01.

Radiographic studies of laterally colliding, diverging, cylindrical detonation waves in PBX 9404 are reproduced numerically by use of the two dimensional Lagrangian hydrodynamic code 2DL with a shock initiation burn model called Forest Fire. The formation and growth of a Mach stem is described.

3568 (UCID—18280) **Plan for studying the thermo-mechanical parameters which influence premature ignitions in artillary projectiles filled with castable secondary explosives.** Sadik, S. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 21 Sep 1979. Contract W-7405-ENG-48. 38p. Dep. NTIS, PC A03/MF A01.

Thermo-mechanical parameters affecting premature ignitions are discussed. The factors required for ignition of Composition-B through gas compression and friction are discussed in detail. The thermal and mechanical properties which influence this proposed behavior are discussed. An integrated analytic and experimental effort to verify and quantify these proposed effects is discussed.

3569 (UCRL—15104) **Mechanisms of nitramine decomposition: very low-pressure pyrolysis of HMX and dimethylnitramine. Final report.** McMillen, D.F.; Barker, J.R.; Lewis, K.E.; Trevor, P.L.; Golden, D.M. (SRI International, Menlo Park, CA (USA)). 18 Jun 1979. Contract W-7405-ENG-48. 38p. Dep. NTIS, PC A03/MF A01.

The very low-pressure pyrolysis (VLPP) of cyclotetramethylenetetranitramine (HMX) and dimethylnitramine have been studied over the temperature ranges 530 to 645 K and 550 to 840 K, respectively. High pressure limit Arrhenius parameters for HONO elimination and $N\text{-}NO_2$ bond scission in dimethylnitramine have been determined to be log $k(sec^{-1})$ = 12.4 +- 0.8 - (37 +- 1.8)/2.3 RT and log $k(sec^{-1})$ = 16.5 +- 0.8 - (48.5 +- 1.8)/2.3 RT, respectively. Use of the dimethylnitramine decomposition parameters as models for HMX decomposition suggests that HONO elimination and $N\text{-}NO_2$ bond scission should have equal rates at about 600 K. Above this temperature, $N\text{-}NO_2$ bond scission will become increasingly predominant. The observed temperature dependence of HMX decomposition is consistent with an activation energy $\leqq$ 40 kcal/mole, but the data are too scattered to completely rule out the 45.50 kcal/mole which would signify initial $N\text{-}NO_2$ bond scission. The decomposition of HMX yields m/e 46 as a major initial product mass, consistent with either pathway, but not consistent with either concerted or stepwise depolymerization as the probable initial step(s) in HMX decomposition.

NUCLEAR

3570 (AD-A—063481) **Huff, a one-dimensional hydrodynamics code for strong shocks. Master's thesis.** Peters, D.J. (Air Force Inst. of Tech., Wright-Patterson AFB, OH (USA). School of Engineering). Dec 1978. 107p. NTIS PC A06/MF A01.

HUFF is a one-dimensional Lagrangian hydrodynamics computer code developed from the basic principles of mass, momentum, and energy conservation for strong shock propagation in a solid or gas. Two equations of state are used - the adiabatic ideal gas law with a variable gamma and the Gruneisen solid equation of state with a constant Gruneisen ratio. The Richtmyer and Morton difference equations for strong shocks are used on a spatial mesh composed of up to 100 cells. Results for two problems are presented which show the usefulness and limitations of the code and also serve as sample problems. The results of a one kiloton nuclear explosion are compared to the Nuclear Blast Standard 1KT. The results were within 13 percent for shock overpressure and overdensity, 5 percent for shock material velocity, and 2 percent for shock position over a range of 20 meters to 2 kilometers from the burst point. The larger deviations occurred at early times being attributed to an absence of radiation transport calculations in the code. The second problem, a megabar compression of uranium, shows agreement within two percent for all parameters (peak shock pressure, density, material velocity and shock velocity) when compared with the Rankine-Hugoniot compression curves. The equation of state for a solid was limited to calculations below 100 megabars due to its simplicity and constant value for the Gruneisen ratio. A complete users guide and program listing are also provided.

3571 (AD-A—063537) **User's manual for CASSANDRA: cloud snapshots of dust raised aloft. Final report.** Showers, R.L.; Crisco, C. (Army Armament Research and Development Command, Aberdeen Proving Ground, MD (USA). Ballistics Research Lab.). Nov 1978. 171p. NTIS PC A08/MF A01.

The computer code, Cloud Snapshots of Dust Raised Aloft (CASSANDRA), was developed to simulate the spatial distribution and concentrations of dust raised aloft by a nuclear cloud. The code utilizes the DELFIC cloud rise description as the basis for a dynamic wafer shape/transport model. Dust concentration for a particular particle size class is calculated directly from the radius of the contributing wafer at the altitude of interest. The outputs of the program are either an array of numbers specifying the values of collective dust density on a gridwork of points in space or a tabulation of dust concentration at specified coordinates and times. As a test case a simulation of the high explosive test Dial Pack was performed. The computed values were within the range of values reported from the cloud sampling. In addition to a general description of the code, a user's guide has been incorporated. Examples have been included of computer generated output along with a complete listing of the CASSANDRA code.

3572 (AD-A—063600) **Attenuation of EMP in the wave zone due to imperfectly conducting ground. Topical report January-June 1978.** Longmire, C.L. (Mission Research Corp., Santa Barbara, CA (USA)). Jun 1978. Contract DNA001-78-C-0141. 34p. NTIS PC A03/MF A01.

Previously, EMP fields from nuclear surface bursts have been extrapolated to points far beyond the source region by use of a multipole extrapolation based on perfect ground conductivity. This report presents a method for correcting the extrapolated fields to account for actual ground impedance. The method is shown to compare favorably with Sommerfeld's solution for a dipole radiating over a flat earth. (Author)

WEAPONRY

3573 (AD-A—063514) **The nuclear hardening of army tactical systems: a trade-off methodology. Final report.** Schwenk, R.M.; Klopcic, J.T. (Army Armament Research and Development Command, Aberdeen Proving Ground, MD (USA). Ballistics Research Lab.). Nov 1978. 25p. NTIS PC A02/MF A01.

Presented is a trade-off methodology for quantitatively optimizing the nuclear hardening of Army tactical systems based on operational impact and life-cycle cost. Included is a proposed set of procedures and analyses which provide a systematic approach for ensuring nuclear hardening predicated upon mission-related survivability criteria and relative military worth. The methodology closely parallels current COEA(Cost and Operational Effectiveness Analysis) designs and, as such, is applicable as a comprehensive, readily-adaptable, Army-wide program.

3574 (AD-A—063571) **Nuclear effects of army materiel (blast). Test operations procedure. Final report.** (Army Test and Evaluation Command, Aberdeen Proving Ground, MD (USA)). 9 Nov 1978. 22p. NTIS PC A02/MF A01.

This report provides procedures for performing nuclear weapon blast effects tests on Army weapon systems and combat support materiel. It also discusses types of blast facilities used to simulate the nuclear weapon blast environment. Test procedures, safety, and instrumentation are covered. It applies to vehicles (land, amphibious, tracked, wheeled), missile systems, self-propelled or towed guns, and electronic equipment.

EXPLOSION DETECTION

3575 (AD-A—063485) **Source amplitudes of NTS explosions inferred from Rayleigh waves at Albuquerque and Tucson. Topical report.** Bache, T.C.; Rodi, W.L.; Mason, B.F. (Systems, Science and Software, La Jolla, CA (USA)). Jun 1978. Contract F08606-76-C-0041,. 100p. NTIS PC A05/MF A01.

Comparing observed and synthetic seismograms, source amplitudes of NTS explosions are inferred from Rayleigh wave recordings from the WWSSN stations at Albuquerque, New Mexico (ALQ) and Tucson, Arizona (TUC). The potential influence of source complexities, particularly surface spallation and related phenomena, is studied in detail. As described in earlier work by Bache, Rodi and Harkrider, the earth model for the synthetic were converted from observations at ALQ and TUC. The agreement of observed and synthetic seismograms is quite good and is sensitive to important features of the source.

3576 (AD-A—063539) **Investigation of large scale optical flash sources. Final report 6 June 1977-31 January 1978.** Cockayne, J.E.; Knasel, T.M.; McDonnell, M.D. (Science Applications, Inc., McLean, VA (USA)). 30 Apr 1978. Contract DNA001-77-C-0231. 73p. NTIS PC A04/MF A01.

This report analyzes the use of optical flash sources in testing of Nuclear Burst Detection System (NBDS) devices. The primary case studied is that of the use of thermochemical reactions to simulate nuclear fireballs. The report reviews the NBDS requirements and weapon output, contrasting the outputs of a variety of simulation sources. Of the sources studied, the thermochemical reactions require detailed modeling, and this is reported. Two general types of models are reported. The first is based on very simple thermal behavior but predicts the growth of fireballs in agreement with previous thermochemical tests of a wide variety of types and sizes. The second type of model considers each step in detail in the fireball development. This is useful for tailoring of the fireball output. Detailed data comparison with a number of thermochemical reaction tests and recommendations conclude the report. (Author)

3577 (NTIS/PS—79/0237) **Seismic detection. Part 2. Nuclear events. Volume 3. 1975-February, 1978 (a bibliography with abstracts). Report for 1976.** Habercom, G.E. Jr. (National Technical Information Service, Springfield, VA (USA)). Apr 1979. 301p. NTIS PC N01/MF N01.

Methods of seismic detection of nuclear events are investigated in the Government sponsored research reports. Data acquisition techniques, data processing, and data collection sources are reviewed. (This updated bibliography contains 292 abstracts, none of which are new entries to the previous edition.)

3578 (NTIS/PS—79/0238) **Seismic detection. Part 2. Nuclear events. Volume 4. March, 1978-March, 1979 (a bibliography with abstracts). Report for Mar 1978-1979.** Habercom, G.E. Jr. (National Technical Information Service, Springfield, VA (USA)). Apr 1979. 56p. NTIS PC N01/MF N01.

Methods of seismic detection of nuclear events are investigated in the Government sponsored research reports. Data acquisition techniques, data processing, and data collection sources are reviewed. (This updated bibliography contains 47 abstracts, all of which are new entries to the previous edition.)

ENVIRONMENTAL SCIENCES, ATMOSPHERIC

REFER ALSO TO CITATION(S) 3289

BASIC STUDIES

REFER ALSO TO CITATION(S) 2720, 3265

3579 (DOE/EV—0046(Vol.1), pp 237-259) **Environmental control technology for carbon dioxide.** Steinberg, M.; Albanese, A.S.; Dang, V.D. (Brookhaven National Lab., Upton, NY). Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

The possible adverse global environmental effects of CO_2 buildup due to fossil fuel energy utilization have prompted an investigation of possible methods for its control. A systematic overview is presented for various routes for removal, recovery, disposal and use of CO_2 from various control points in the global system. The effect of substitute alternative non-fossil energy sources on the global CO_2 problem is evaluated. The energy and mass balances for a number of removal and recovery routes are used as evaluation criteria. Flow sheets are presented for conversion of CO_2 from various sources to synthetic carbonaceous fuels with the use of non-fossil energy. Several unique CO_2 disposal alternatives are presented and discussed. Many of the feasibility studies considered are treated in more detail than in other papers in the system. (LTN)

3580 (DOE/EV—0046(Vol.1), pp 260-271) **Options for collection and disposal of carbon dioxide from concentrated sources.** Baes, C.F. Jr. (Oak Ridge National Lab., TN); Beall, S.E.; Marland, G. Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

The cost of recovery of carbon dioxide from the stack gas of fossil-fuel power plants and its disposal in the ocean are considered. It is concluded that: the cost of CO_2 recovery from flue gas will be high; combustion of fuel in pure oxygen may permit a more efficient recovery of CO_2 (and SO_2), partly because of improvement in overall efficiency of the plant, lower heat losses, less combustion air power, etc.; deep ocean disposal would give a long retention time; fresh water is not a suitable medium for disposal; seawater could be used because dissolving CO_2 should increase the density of seawater; the cooling water flow from a fossil fuel plant is more than adequate to accomodate the CO_2 output of the plant, but the plant must be sited to permit ocean disposal; we need more data on the density effect of introducing CO_2 into seawater as a function of temperature and pressure; we need to know more of the rate of descent and spreading of the vertical plume formed by a CO_2 disposal stream; other forms of CO_2 suitable for disposal may include the hydrate and dry ice; and liquid CO_2 might be used for ocean disposal, but the depth of injection would be over 3,000 m.

3581 (EPRI-EA—1131(App.A)) **Mathematical models for atmospheric pollutants. Appendix A. Elements of meteorology. Final report.** Drake, R.L.; Laulainen, N.S. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Aug 1979. Contract EY-76-C-06-1830. 98p. Dep. NTIS, PC A05/MF A01.

The meteorological elements that are important in the transport and fate of airborne pollutants are summarized. The summary consists of descriptions of the thermal, water, kinematic and dynamic structures of the atmosphere, the time and space scale classifications of atmospheric motions, and modifications of pollutant plumes as they pass over nonhomogeneous surface conditions and complex terrain. The discussions consider the atmospheric thermal layers and their stability, formation of clouds and the production of rain and snow, the movement of air masses and weather fronts, the horizontal winds in the planetary boundary layer, and wind profiles over transition zones and complex terrain.

3582 (EPRI-EA—1131(App.B)) **Mathematical models for atmospheric pollutants. Appendix B. Chemical and physical properties of gases and aerosols. Final report.** Drake, R.L.; Hales, J.M.; Mishima, J.; Drewes, D.R. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Aug 1979. Contract EY-76-C-06-1830. 82p. Dep. NTIS, PC A05/MF A01.

Some of the important chemical and physical properties of gases and aerosols are described. These properties are required to determine the fate of airborne pollutants. In order to understand the reaction mechanisms and rates in the troposphere, the following chemical elements are discussed in the order of their increasing complexity in atmospheric reactions: hydrogen, oxygen, nitrogen, sulfur, and carbon. The tropospheric aerosol is considered from the point-of-view of an evolving population of particles. Particle and population properties are described, and examples of atmospheric aerosol distributions are presented. Finally, the sources and properties of airborne radionuclides from light-water reactors are discussed.

3583 **Sensitivity of a cloud microphysical model to an urban environment.** Ochs, H.T. III; Semonin, R.G. (Illinois State Water Survey, Urbana 61801). EY-76-S-02-1199. *J. Appl. Meteorol.;* **18**: No. 9, 1118-1129(Sep 1979).

Observations showed increased concentrations of cloud condensation nuclei (CCN) in air samples collected over and downwind of St. Louis when compared to upwind samples. Aircraft observations of urban clouds showed corresponding increased concentrations of cloud base droplets. In addition, observations indicated higher cloud bases and decreased elevations of average first echo base heights in the St. Louis/East St. Louis area as compared with similar clouds over rural areas.The purpose of this paper is to examine the possible role of CCN chemical composition and number concentration in producing the observed phenomena. A closed parcel model of condensation and collection was employed for this purpose. The results suggest that the observed differences of depth from cloud base to first echo height between urban and rural clouds do not result from concentration differences in any CCN size range. Results of model calculations also suggest that variations in chemical composition of the largest CCN ($>1.0\mu m$ radius) were not responsible for the observed urban/rural differences. A hypothesis based on observations and model results is presented for explaining the observed differences in cloud base to first echo depth in terms of differences between the evolution and strength of updrafts in urban and rural clouds.

3584 **Radiocarbon dating with a cyclotron.** Stephenson, E.J.; Mast, T.S.; Muller, R.A. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). *Nucl. Instrum. Methods;* **158**: No. 2, 571-577(15 Jan 1979).

A technique is described for detecting and measuring the high energy ^{14}C beam from a natural sample ionized in the Berkeley 88" cyclotron. An intense nitrogen background was removed by using its shorter range in a xenon gas cell immediately ahead of the detector. Beams from several samples were compared by rapidly switching the CO_2 gas source feed. The ^{14}C concentration in an unknown sample was measured relative to that of a sample 465 years old to obtain an age of (5900+-800)y.

3585 **Climate and solar energy conversion.** Williams, J.; Kroemer, G.; Weingart, J. (eds.). Laxenburg, Austria; International Institute for Applied Systems Analysis (1977). 153p. (CP—77-9; CONF-761233—).

From Acoustic emission meeting; London, UK (20 Dec 1976).

Seven papers were included. One paper was abstracted previously. Separate abstracts were prepared for six papers and the summary of the workshop discussions. (MHR)

3586 **Scenario for albedo modification due to intensive solar energy production.** Grether, D.; Davidson, M.; Weingart, J. pp 109-122 of Climate and solar energy conversion. Williams, J.; Kroemer, G.; Weingart, J. (eds.). Laxenburg, Austria; International Institute for Applied Systems Analysis (1977).

From Acoustic emission meeting; London, UK (20 Dec 1976).

A global scenario is presented to estimate the maximum credible deployment of solar thermal power generation in the future. The modification of the natural albedo is estimated in this case and shown to be of such a magnitude that global climate modification appears possible. The maximal solar thermal scenario considered has more solar thermal production than is likely to occur and thus produces climate effects which can be used to bound any effects that might occur in a less expensive scenario.

CHEMICALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 2714, 3665, 3667

3587 (AD-A—063586) **Recent developments in the estimation of potential effects of high altitude aircraft emissions on ozone and climate. Interim report 15 April 1977-15 October 1978.** Oliver, R.C.; Bauer, E.; Wasylkiwskyj, W. (Institute for Defense Analyses, Arlington, VA (USA)). Oct 1978. Contract DOT-FA77WA-3965. 198p. NTIS PC A09/MF A01.

A review is provided of recent (December 1976-June 1978) developments in problems associated with estimating the potential effects that aircraft emissions at cruise altitudes may have on the earth's protective ozone shield and/or surface climate. Background information is provided as deemed necessary for context. The review shows that one recently measured key reaction rate(HO2 + NO yields NO2 + HO) has had dramatic effects on the ozone question. Computed effects on the ozone column of nitrogen oxides (which, unless in very large quantity, now cause an increase) and water vapor emissions (which, unless thermal feedback effects are included, cause a decrease) from supersonic transports (at 17-20 km) are now small and, on balance, apparently positive, at least for moderate fleets (several hundred aircraft). Subsonic aircraft also appear to cause small increases in the ozone column; however, no new modeling results are available. The new HO2 + NO rate has affected model duplication of the natural atmosphere adversely; another important new rate (HO2 + O3 yields HO + 2 O2), not yet incorporated in available results, may reduce this difficulty. Second-order effects (thermal feedback) have become important, particularly in modeling water effects; the modeling of water transport processes, however, involves many uncertainties. Additional modeling studies are needed. Progress in emissions measurement uncertainties and brief comments on possibly important climatic aspects are also included. (Author)

3588 Fate of pollutants in the air and water environments. Part 1. Mechanism of interaction between environments and mathematical modeling and the physical fate of pollutants. Suffet, I.H. (ed.). New York, NY; John Wiley and Sons, Inc. (1977). 501p. (CONF-750410—P4).

From 169. national meeting, American Chemical Society; Philadelphia, PA, USA (6 Apr 1975).

Papers are presented on the mechanisms of interaction between environments and methods of mathematical modeling, the fate of pollutants, and the physical fate of pollutants. Papers in scope for ERA/EDB were abstracted and indexed individually. (JGB)

3589 (COO—2874-53) **Inter-station correlations of ozone concentrations in the San Francisco Bay area.** Hayashi, C. (Stanford Univ., CA (USA)). May 1979. Contract EY-76-S-02-2874. 12p. Dep. NTIS, PC A02/MF A01.

This project was undertaken primarily to show how one might use SPSS (Statistical Package for the Social Sciences) to analyze air pollution data. As an example, an examination was made of the ozone concentration correlation coefficients between the 25 BAAPCD's (Bay Area Air Pollution Control Districts) for the months of July, August and September 1978.

3590 (EML—359) **Air sampling workshop: October 24-25, 1978.** (Department of Energy, New York (USA). Environmental Measurements Lab.). Jun 1979. 26p. Dep. NTIS, PC A03/MF A01.

A two-day workshop was held in October 1978 on air sampling strategies for the occupational environment. Strategies comprise the elements of implementing an air sampling program including deciding on the extent of sampling, selecting appropriate types of measurement, placing sampling instruments properly, and interpreting sample results correctly. All of these elements are vital in the reliable assessment of occupational exposures yet their coverage in the industrial hygiene literature is meager. Although keyed to a few introductory topics, the agenda was sufficiently informal to accommodate extemporaneous discussion on any subject related to sampling strategies. Questions raised during the workshop mirror the status of air sampling strategy as much as the factual information that was presented. It may be concluded from the discussion and questions that air sampling strategy is an elementary state and urgently needs concerted attention from the industrial hygiene profession.

3591 (EPRI-EA—1131) **Mathematical models for atmospheric pollutants. Final report.** Drake, R.L.; Barrager, S.M. (Battelle Pacific Northwest Labs., Richland, WA (USA); Decision Focus, Inc., Palo Alto, CA (USA)). Aug 1979. Contract EY-76-C-06-1830. 116p. Dep. NTIS, PC A06/MF A01.

The present and likely future roles of mathematical modeling in air quality decisions are described. The discussion emphasizes models and air pathway processes rather than the chemical and physical behavior of specific anthropogenic emissions. Summarized are the characteristics of various types of models used in the decision-making processes. Specific model subclasses are recommended for use in making air quality decisions that have site-specific, regional, national, or global impacts. The types of exposure and damage models that are currently used to predict the effects of air pollutants on humans, other animals, plants, ecosystems, property, and materials are described. The aesthetic effects of odor and visibility and the impact of pollutants on weather and climate are also addressed. Technical details of air pollution meteorology, chemical and physical properties of air pollutants, solution techniques, and air quality models are discussed in four appendices bound in separate volumes.

3592 (EPRI-EA—1131(App.C)) **Mathematical models for atmospheric pollutants. Appendix C. Governing equations for atmospheric trace constituents and solution techniques. Final report.** Drake, R.L. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Aug 1979. Contract EY-76-C-06-1830. 252p. Dep. NTIS, PC A12/MF A01.

The governing equations for the evolution and fate of airborne gases and particles are described, and exact and approximate solution techniques are presented. Among the systems of equations are: the conservation of mass, momentum and energy and the equation of state for defining the motion, pressure, density and temperature fields of the atmosphere; the conservation of liquid water and water vapor; the radiation equations for the solar and terrestrial radiation intensities; the conservation equations for nonreactive and reactive gases and aerosols. The techniques for obtaining exact solutions of diffusion and aerosol equations are: series methods, integral transforms, similarity techniques, principle of superposition and Green's functions. Among the approximate solution techniques described in this document are: the classical techniques, such as successive approximations, asymptotic techniques, perturbation methods, the method of moments and integral methods; random walk and Monte are seriesarlo techniques; finite difference methods; spectral and variational methods, including finite element techniques.

3593 (EPRI-EA—1131(App.D)) **Mathematical models for atmospheric pollutants. Appendix D. Available air quality models. Final report.** Drake, R.L.; McNaughton, D.J.; Huang, C. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Aug 1979. Contract EY-76-C-06-1830. 140p. Dep. NTIS, PC A07/MF A01.

Models that are available for the analysis of airborne pollutants are summarized. In addition, recommendations are given concerning the use of particular models to aid in particular air quality decision making processes. The air quality models are characterized in terms of time and space scales, steady state or time dependent processes, reference frames, reaction mechanisms, treatment of turbulence and topography, and model uncertainty. Using these characteristics, the models are classified in the following manner: simple deterministic models, such as air pollution indices, simple area source models and rollback models; statistical models, such as averaging time models, time series analysis and multivariate analysis; local plume and puff models; box and multibox models; finite difference or grid models; particle models; physical models, such as wind tunnels and liquid flumes; regional models; and global models.

3594 (LA—8061-MS) **Filter weight stability evaluation.** Lowry, P.L.; Tillery, M.I. (Los Alamos Scientific Lab., NM (USA)). Oct 1979. Contract W-7405-ENG-36. 19p. Dep. NTIS, PC A02/MF A01.

Several types of 37-mm-diam filters were exposed to a variety of temperature and humidity conditions to evaluate the effects of these conditions on filter weight stability. Temperatures ranged from 5 to 32°C, and relative humidity ranged from less than 10 to 80%. The magnitude of weight change was determined for each filter type and test condition. A set of reference masses was weighed to establish the precision of the weighing technique. Results revealed that some filters were weight stable while other filters showed weight changes of 400 to 500 μg. The precision of the weighing technique based on the reference masses was estimated to be +-12 μg. Of the test conditions, desiccation had the least effect on filter weight. Based on these data, a procedure to minimize filter weight variation is recommended.

3595 (LA-UR—79-2421) **Prototype particulate stack sampler with single-cut nozzle and microcomputer calculating/display system.** Eler, J.C.; Littlefield, L.G.; Tillery, M.I. (Los Alamos Scientific Lab., NM (USA)). 1979. Contract W-7405-ENG-36. 20p. (CONF-791018—1). Dep. NTIS, PC A02/MF A01.

From Symposium on advances in particulate sampling and measurement; Daytona Beach, FL, USA (7 Oct 1979).

A prototype particulate stack sampler (PPSS) has been developed to improve on the existing EPA Method 5 sampling apparatus. Its primary features are (1) higher sampling rate (56 l/min); (2) display (on demand) of all required variables and calculated values by a microcomputer-based calculating and display system; (3) continuous stack gas moisture determination; (4) a virtual impactor nozzle with 3 μm mass median diameter cutpoint which collects fine and coarse particle fractions on separate glass fiber filters; (5) a variable-area inlet to maintain isokinetic sampling conditions; and (6) conversion to stainless steel components from the glass specified by EPA Method 5. The basic sampling techniques of EPA Method 5 have been retained; however, versatility in the form of optional in-stack filters and general modernization of the stack sampler have been provided in the prototype design. Laboratory testing with monodisperse dye aerosols has shown the present variable inlet, virtual impactor nozzle to have a collection efficiency which is less than 77% and significant wall losses. This is primarily due to lack of symmetry in this rectangular jet impactor and short transition lengths dictated by physical design constraints (required passage of the nozzle through a 7.6 cm (3 in) diameter stack port). Electronic components have shown acceptable service in laboratory testing although no field testing of the prototype under a broad range of temperature, humidity, and SO_2 concentration has been undertaken.

3596 (NTIS/PS—79/0066) **Detection and sampling in flue gases (citations from the American Petroleum Institute data base). Report for 1974-November 1978.** Cavagnaro, D.M. (National Technical Information Service, Springfield, VA (USA)). Mar 1979. 144p. NTIS PC N01/MF N01.

This bibliography discusses the detection and sampling of combustion flue gases within the stack and at the stack exit. The aspects covered include detection design and detection techniques for pollutants, such as NOX, SO2, CO, and particles. (Contains 137 abstracts)

3597 (ORNL/TM—6930) **Feasibility of conducting wetfall chemistry investigations around the Bowen Power Plant.** Chen, N.C.J.; Patrinos, A.A.N. (Oak Ridge National Lab., TN (USA)). Oct 1979. Contract W-7405-ENG-26. 83p. Dep. NTIS, PC A05/MF A01.

The feasibility of expanding the Meteorological Effects of Thermal Energy Releases - Oak Ridge National Laboratory (METER-ORNL) research at Bower Power Plant, a coal-fired power plant in northwest Georgia, to include wetfall chemistry is evaluated using results of similar studies around other power plants, several atmospheric washout models, analysis of spatial variability in

precipitation, and field logistical considerations. An optimal wetfall chemistry network design is proposed, incorporating the inner portion of the existing rain-gauge network and augmented by additional sites to ensure adequate coverage of probable target areas. The predicted sulfate production rate differs by about four orders of magnitude among the models reviewed with a pH of 3. No model can claim superiority over any other model without substantive data verification. The spatial uniformity in rain amount is evaluated using four storms that occurred at the METER-ORNL network. Values of spatial variability ranged from 8 to 31% and decreased as the mean rainfall increased. The field study of wetfall chemistry will require a minimum of 5 persons to operate the approximately 50 collectors covering an area of 740 km^2. Preliminary wetfall-only samples collected on an event basis showed lower pH and higher electrical conductivity of precipitation collected about 5 km downwind of the power plant relative to samples collected upwind. Wetfall samples collected on a weekly basis using automatic samplers, however, showed variable results, with no consistent pattern. This suggests the need for event sampling to minimize variable rain volume and multiple-source effects often associated with weekly samples.

3598 (PB—290594) **Ozone/ultraviolet radiation monitoring. Final report.** (Radian Corp., Austin, TX (USA)). Jun 1978. 29p. NTIS PC A03/MF A01.

As part of the Houston Area Oxidants Study, Radian Corporation monitored ambient levels of ozone and ultraviolet radiation at a site northwest of Houston, Texas. The monitoring was performed from June 15, 1977 to October 31, 1977. This report presents the data accumulated during this study. A total of 3,248 hours of ozone data and 2,891 hours of ultraviolet radiation data were collected. The highest hourly ozone average was 307 parts per billion (ppb) and was observed on July 13 from 1700 to 1800. The second highest hourly average was 255 ppb and was observed for hours 1600 to 1700 and 1800 to 1900 on July 13. A one-hour average of 80 ppb ozone was attained or exceeded for at least one hour in each of 44 days. The peak ultraviolet radiation levels observed were four langleys.

3599 (PB—291823) **A study of ozone concentrations in southern Louisiana. Final report.** Stuart, J.D.; Haecker, M.A.; Williamson, H.J.; Harper, D.L.; Lambeth, B.W. (Radian Corp., Austin, TX (USA)). Sep 1978. Contract EPA-68-02-1383. 98p. NTIS PC A05/MF A01.

This report describes an air quality and meteorological monitoring program conducted at nine sites in southern Louisiana from July through October 1976. The objective of this monitoring program was to provide air quality data applicable to non-urban portions of southern Louisiana and to perform a limited analysis of the data gathered. It was found that the frequency of observations exceeding the 80 ppb standard for ozone at the nine sites ranged from four to seventeen percent of available observation with ten percent of the total number of observations exceeding a concentration of 80 ppb. Five percent of the total ozone observations exceeded a concentration of 100 ppb. The diurnal oxidant pattern at each of the sites is similar to patterns typically found in urban areas. It was not possible to ascertain the cause of the high ozone measurements, but examination of upper air trajectories for periods of high ozone concentrations shows that local urban sources are important contributors. Overall the NO2 and SO2 levels at all of the monitoring sites was very low. No concentrations of these pollutants in excess of air quality standard values were observed.

3600 (SAND—79-8056) **Particulate size measurements using light scattering techniques.** Wang, J.C.F.; Tichenor, D. (Sandia Labs., Livermore, CA (USA)). Sep 1979. Contract EY-76-C-04-0789. 36p. (CONF-790855—4). Dep. NTIS, PC A03/MF A01.

From Symposium on instrumentation and control for fossil energy processes; Denver, CO, USA (20 Aug 1979).

Particle size distribution measurements using a small-angle near-forward light scattering (SANFS) arrangement have been found to be a promising technique for applications in combustor environments and advanced power systems. In this paper, characteristics of the light scattering response for this optical arrangement are discussed in detail based on Mie theory calculations. Preliminary data from a bench-scale experiment and a means to improve measurement accuracy are reported.

3601 **Instantaneous global nitrous oxide photochemical rates.** Johnston, H.S.; Serang, O.; Podolske, J. (Department of Chemistry and Materials and Molecular Research Division, Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *J. Geophys. Res.;* **84**: No. C8, 5077-5082(20 Aug 1979).

In recent years, vertical profiles of nitrous oxide have been measured by balloon up to midstratosphere at several latitudes between 63 °N and 73 °S, including one profile in the tropical zone at 9 °N. Two rocket flights measured nitrous oxide mixing ratios at 44 and 49 km. From these experimental data plus a large amount of interpolation and extrapolation, we have estimated a global distribution of nitrous oxide up to the altitude of 50 km. With standard global distributions of oxygen and ozone we carried out instantaneous, three-dimensional, global photochemical calculations, using recently measured temperature-dependent cross sections for nitrous oxide. The altitude of maximum photolysis rate of N_2O is about 30 km at all latitudes, and the rate of photolysis is a maximum in tropical latitudes. The altitude of maximum rate of formation of nitric oxide is latitude dependent, about 26 km at the equator, about 23 km over temperate zones, and 20 km at the summer pole. The global rate of N_2O destruction is 6.2×10^{27} molecules s^{-1}, and the global rate of formation of NO from N_2O is 1.4×10^{27} molecules s^{-1}. The global N_2O inventory divided by the stratospheric loss rate gives a residence time of about 175 years with respect to this loss process. From the global average N_2O profile a vertical eddy diffusion profile was derived, and this profile agrees very closely with that of Stewart and Hoffert (1975).

3602 **Disposition of ^{131}I proinsulin in the rat comparisons with ^{131}I insulin.** Izzo, J.L.; Roncone, A.M.; Helton, D.L.; Izzo, M.J. (Univ. of Rochester, NY). *Diabetes;* **27**: No. 4, 400-410(Apr 1978).

The patterns of disposition of intravenously injected doses of ^{131}I proinsulin and ^{131}I insulin were compared in the rat with respect to plasma clearance, uptake, and degradation in selected organs and tissues, and rates of accumulation of degraded products in plasma and urine. The studies indicate that the differences in dose dependency in plasma clearance and degradation of ^{131}I insulin and ^{131}I proinsulin can be attributed to differences in relative uptakes and degradation by the liver and kidneys. The liver appeared to be the major organ involved in the removal and degradation of insulin, whereas the kidney appeared to be the major organ involved in the case of proinsulin. The hepatic process was rapid but relatively saturable, whereas the kidney process was slower but relatively unsaturable. The inverse relationship between initial concentration of hormone in plasma and uptake by liver suggests that the ratio may provide a sensitive index of the role of the liver in plasma hormone clearance.

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 2678, 3582, 3590, 3655

REGULATIONS

REFER ALSO TO CITATION(S) 3165

3603 (SAND—79-1536) **Environment, Safety, and Health Assurance Program Standard: analysis in the context of Department of Energy environment, safety, and health requirements.** Ellingson, A.C.; Trauth, C.A. Jr. (Sandia Labs., Albuquerque, NM (USA)). Sep 1979. Contract EY-76-C-04-0789. 45p. Dep. NTIS, PC A03/MF A01.

An Environment, Safety and Health (ES and H) Assurance Program Standard is presented. The Standard was published for comments in a previous document, and has been revised as a result of those comments. The benefits of using the Standard are described and, through the use of comparisons, it is demonstrated that the requirements of the applicable Department of Energy (DOE) Orders are satisfied by a program designed in accordance with the Standard.

3604 **Effect of environmental regulations on the General Electric research and development program for combustion turbines using coal-derived fuels.** Dibelius, N.R.; Ketterer, R.J.; Manning, G.B. (GE, Schenectady, NY). *Am. Soc. Mech. Eng.*, [*Pap.*]; No. 79-Gt-41, 1-9(1979).

This paper discusses the Clean Air Act, the Clean Water Act, and Noise Control Act as they affect stationary combustion turbines, including combustion turbines on coal-derived liquid and gaseous fuels. It also includes a discussion of regulations resulting from these acts insofar as they existed as of July, 1978. New regulations are being added periodically. This situation will continue and therefore requires that the most recent regulations be consulted for any given case.

ENVIRONMENTAL SCIENCES, TERRESTRIAL

BASIC STUDIES

REFER ALSO TO CITATION(S) 3662

3605 (DOE/SF/01525—1) **Research on dynamics of tundra ecosystems and their potential response to energy resource development. Progress report, May 1, 1978-April 30, 1979.** Miller, P.C. (San Diego State Univ., CA (USA)). Jan 1979. Contract EE-77-S-03-1525. 133p. Dep. NTIS, PC A07/MF A01.

The ecological effects (costs and benefits) of impacts that can be expected from the development and utilization of energy resources in the arctic. The impacts selected for study are: altered nutrient availability (nitrogen and phosphorus); altered patterns of soil water drainage; and vehicle tracks. The general ecosystem characteristics chosen to provide integrative measures of the possible ecological effects include annual primary production and the relative aboveground growth of the different species or growth forms comprising the vegetation. Plant growth forms are defined by height, leaf longevity, position of the perennating bud, and rooting pattern. The growth forms and species selected are: erect deciduous shrubs (Betula nana, Vaccinium uliginosum, Salix pulchra); erect evergreen shrubs (Ledum palustre); prostrate evergreen shrub (Vaccinium vitis-idaea); tussock graminoid (Eriophorum vaginatum); rhizomatous graminoid (Carex bigelowii, Carex aquatilis, Eriophorum angustifolium); forb (Artemisia arctica); grass (Calamagrostis or Arctagrostis); cushion moss (Dicranum sp.); Sphagnum sp.; and Polytrichum commune. Progress is reported in field and laboratory studies. The main conclusion of the research is that species respond individually in terms of nutrient and total nonstructural carbohydrates accumulation to fertilization, and that the growth forms studied are not distinctive from each other on the basis of plant nutrition or growth. The explicit mechanism for integrating and guiding this research and for extrapolating the existing data base to make quantitative predictions of the effects of perturbations is a simulation model of arctic tundra vegetation and soil processes called ARTUS (Arctic Tundra Simulator). (JGB)

3606 **Paleoecology of desert vegetation and rodents in the Great Basin.** Schreiber, R.K. (Oak Ridge National Lab. TN). *Biologist (Champaign, Ill.);* **60**: No. 1, 19-33(Feb 1978).

Paleoecology is the study of past biota on the basis of ecological concepts and methods insofar as they can be applied. With this approach it is necessary to assume that the operation of ecological principles has been essentially the same throughout geologic time. It also assumes the ecology of fossils may be inferred from what is known about equivalent or related living species. This paper reviews the evolutionary development of flora and heteromyid rodents in a specific climatic region of western North America, the Great Basin. The paucity of fossil remains of both vegetation and rodents from this area necessitates the adoption of the preceding suppositions. The objectives of this paper are threefold: (1) to present an overview of the origin and development of western North American deserts, with particular interest placed on the floral and climatic characters, (2) to trace the evolutionary development of desert rodents, particularly the family Heteromyidae, and (3) to relate the climate and subsequent vegetation changes to the development of heteromyids in arid environments.

CHEMICALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 3588, 3651, 3654, 3665

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 2662, 2678, 3617

SOIL

REFER ALSO TO CITATION(S) 2639, 2666, 2682

3607 (ORNL/TM—7004) **Results of ground level radiation measurements in support of the 1978 aerial survey of the Lake Ontario Ordnance Works, Lewiston, New York.** Berven, B.A.; Doane, R.W.; Haywood, F.F.; Shinpaugh, W.H. (Oak Ridge National Lab., TN (USA)). Sep 1979. Contract W-7405-ENG-26. 86p. Dep. NTIS, PC A05/MF A01.

This report contains the results of a limited series of measurements at the Lake Ontario Ordnance Works site, three miles northeast of Lewiston, New York. The scope of this survey was not extensive, and the survey was conducted to support a concurrent aerial survey conducted by EG and G, Inc. Results of this survey indicate two souces of significant external gamma exposure on the site as well as several locations that retain low to intermediate levels of radioactivity in soil. Off-site soil radionuclide concentrations were well within background levels with one exception. Water radionuclide concentrations on the site in the Central Drainage Ditch are significantly above background levels but decrease with distance from the spoil pile, and are within restrictive concentration guides for off-site locations.

TERRESTRIAL ECOSYSTEMS AND FOOD CHAINS

REFER ALSO TO CITATION(S) 3662

SITE RESOURCE AND USE STUDIES

REFER ALSO TO CITATION(S) 2945, 3166, 3205

3608 (RLO-SA—79-1) **Perspective on Hanford safety and environmental protection.** Fremling, A.G. (Department of Energy, Richland, WA (USA). Richland Operations Office). 25 Jul 1979. 30p. Dep. NTIS, PC A03/MF A01.

Hanford activities and operations past and present are reviewed, with emphasis on those that have potential for adverse safety or environmental impact. Safety and environmental protection requirements and responsibilities are summarized, and the current Hanford environmental surveillance program is outlined. It is concluded that the overall effects of Hanford's operations on people and the environment over the past 36 years have been small. It is perceived that the most difficult challenges are the management and ultimate disposal of the stored wastes. (JGB)

REGULATIONS

REFER ALSO TO CITATION(S) 3603

ENVIRONMENTAL SCIENCES, AQUATIC

BASIC STUDIES

REFER ALSO TO CITATION(S) 3428, 3613

3609 (HEDL-TME—79-38) **Water Use Information System.** Jacobson, L.D.; Sonnichsen, J.C. Jr. (Hanford Engineering Development Lab., Richland, WA (USA)). Sep 1979. Contract EY-76-C-14-2170. 89p. Dep. NTIS, PC A05/MF A01.

The Water Use Information System incorporates data on US water availability and quality and water use-related data on US power generating stations into a computerized data base management system that provides for efficient storage and retrieval of information. Availability and quality data are provided for surface waters, groundwater, and marine waters through the contiguous United States. Both hydroelectric and thermal electric power plant data are included including basic plant data, water consumption and generation data. An auxiliary electrical energy demand water use model has been developed to forecast the electrical demand increase and the subsequent cooling water requirements.

3610 (LA—8074-PR) **Water supply at Los Alamos during 1978. Progress report.** Purtymun, W.D. (Los Alamos Scientific Lab., NM (USA)). Oct 1979. Contract W-7405-ENG-36. 49p. Dep. NTIS, PC A03/MF A01.

The municipal and industrial water supply for Los Alamos for 1978 consisted of 1436 x 10^6 gal from wells in three fields and 45 x 10^6 gal from the gallery in Water Canyon. An additional 1.1 x 10^6 gal of water were pumped to waste during testing of well LA-6. About 3.3 x 10^6 gal of water in the Guaje Reservoir were used for irrigation, thus the total use was about 1485 x 10^6 gal. Water level trends in the wells were as anticipated under current production practices. Projected water level declines or recoveries were made to 1983. Suggestions are presented to reduce the rate of decline in the lower part of the Los Alamos field. Quality of water from wells, gallery, five stations on the distribution system, and Guaje Reservoir is presented. Quality of water is good and meets standards for municipal supply. Well and distribution system rehabilitation and replacement should be continued to ensure an adequate and reliable water supply from the wells and systems.

3611 **Production biology of Eurasian watermilfoil (Myriophyllum spicatum L.): a review.** Grace, J.B.; Wetzel, R.G. (Michigan State Univ., Hickory Corners). *J. Aquat. Plant Manage.;* **16**: vp(1978).

Milfoil seems to be highly successful in colonizing new habitats, replacing other submersed macrophytes and avoiding nutrient limitations. Part of its success is due to a high efficiency in fixing inorganic carbon which may be related to certain anatomical fea-

tures that aid in refixation of respired CO_2. Although based on metabolic criteria milfoil seems to be at a disadvantage in utilizing available light, its growth form seems to be highly compensatory for any metabolic deficiencies. The existing evidence suggests that the ability of milfoil to avoid nutrient limitations, especially by N and P, is the result of root uptake from the sediments and low requirement for these minerals, rather than because of well-adapted uptake kinetics. Despite excessive growth of milfoil, it is not especially productive when considered by quantitative criteria. Therefore, anatomical features, growth form, low requirements of nitrogen and phosphorus, and high vegetative reproductive capacity of this species are implicated as major factors determining its distributional and competitive success.

CHEMICALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 2434, 2505, 2506, 3588, 3609, 3610, 3651, 3652, 3660, 3661, 3665, 3667

3612 (EPA—440/3-77-018) **Assessment of rural nonpoint source pollution: a model based on the universal soil loss equation.** Rimer, A.E. (Wiggins-Rimer and Associates, Durham, NC (USA); American Inst. of Physics, New York; Ohio-Kentucky-Indiana Regional Council of Governments (USA)). Nov 1977. 16p. Environmental Protection Agency, Environmental Research Information Center, 401 M St. SW, Washington, DC 20460.

A methodology was developed for identifying and assessing rural nonpoint source pollutiof problems by the Ohio-Kentucky-Indiana Council of Governments (OKI). The OKI model is based upon the Universal Soil Loss Equation utilized by the Soil Conservation Service (SCS). For each of the 226 rural watersheds, the OKI model and the approach for assessing rural nonpoint sources provided an estimate of the nonpoint source loadings, an identification of problem uses within watersheds, and a means of evaluating alternative management practices for alleviating identified problems. Model results indicated that gross erosion ranged from 0.02 to 32.5 tons per acre per year under existing conditions and provided estimates of sediment, nutrient, and organic matter loads. The model results and supporting information were used to develop a rural nonpoint source control program which keys on the effective application of management practices in prioritied problem areas, and demonstrates the need for an increased Agricultural Conservation Program through local Soil and Water Conservation Districts. (JGB)

3613 **Effectiveness of submersed angiosperm-epiphyte complexes on exchange of nutrients and organic carbon in littoral systems. I. Inorganic nutrients.** Mickle, A.M.; Wetzel, R.G. (Michigan State Univ., Hickory Corners). *Aquat. Bot.*; **4**: vp(1978).

Inorganic chemical parameters were analyzed daily for several weeks in water from an inlet stream of a small hardwater lake before and after passing through two replicated continuously, very slowly flowing (3 1/24 h) littoral systems containing natural stands of submerged Scirpus subterminalis Torr. and of Myriophyllum heterophyllum Michx. Macrophytic epiphytes were left intact. Calcium and alkalinity concentrations of the inflowing water decreased 40 to 45% in passing through the littoral systems. In both systems, pH values increased significantly, but to a greater extent in the more metabolically active Myriophyllum (than the Scirpus) littoral bed. Magnesium concentrations remained constant in passage through both systems. Sodium concentrations were unaffected by the Scirpus system but increased (8%) in the outflow from the Myriophyllum system. In contrast to the Scirpus system where potassium increased slightly, potassium concentrations decreased markedly ($> 30\%$) in passage through the Myriophyllum complex. Nitrate-nitrogen concentrations were reduced significantly and NH_4-N decreased only slightly in both plant systems. Concentrations of NH_4-N and potassium increased markedly in inflow water after periods of rainfall. Both littoral systems were extremely effective in dampening these higher concentrations; only slight increases appeared in the outflows after passing slowly through the littoral complexes.

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 2657, 2678

WATER

REFER ALSO TO CITATION(S) 2663, 2665, 2671, 2681

THERMAL EFFLUENTS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 2926, 3649

3614 (NTIS/PS—79/0256) **Thermal pollution. Part 1. Control techniques and general studies (a bibliography with abstracts). Report for 1964-February 1979.** Brown, R.J. (National Technical Information Service, Springfield, VA (USA)). Apr 1979. 238p. NTIS PC N01/MF N01.

Reports concerned with control techniques for heated effluents from power and industrial plants are cited. Also included are studies on general thermal pollution problems and their abatement. Many reports on the remote sensing of thermal effluents are also cited. However, the control of thermal pollution by using the waste heat for constructive purposes is not covered in this bibliography.

3615 (NTIS/PS—79/0258) **Thermal pollution. Part 3. Hydrology and hydrodynamics (a bibliography with abstracts). Report for 1964-February 1979.** Brown, R.J. (National Technical Information Service, Springfield, VA (USA)). Apr 1979. 230p. NTIS PC N01/MF N01.

Aspects of the hydrology and hydrodynamics of heated effluents are covered in the bibliography, including mixing, diffusion, modeling, heat transfer, and flow. (This updated bibliography contains 221 abstracts, 8 of which are new entries to the previous edition.)

SITE RESOURCE AND USE STUDIES

REFER ALSO TO CITATION(S) 2945, 3610

REGULATIONS

REFER ALSO TO CITATION(S) 3603, 3604

ENVIRONMENTAL-SOCIAL ASPECTS OF ENERGY TECHNOLOGIES

REFER ALSO TO CITATION(S) 2727, 2728, 2729

SOCIAL AND ECONOMIC STUDIES

REFER ALSO TO CITATION(S) 2482, 3183, 3671

3616 (DOE/TIC—10114/1) **Regional environment-energy data book: Rocky Mountain region.** (Los Alamos Scientific Lab., NM (USA)). Dec 1978. Contract W-7405-ENG-36. 902p. Dep. NTIS, PC A99/MF A01.

Regional data relating to the energy, environmental, socioeconomic, and institutional characteristics of the Rocky Mountains are compiled. Intended uses are to provide data for policy analysis and generic impact assessments; assist the labs in developing relevant data to be used in analyses and studies; provide a reference book that can be used by local groups and institutions; and identify the gaps in regional data bases so that the Department of Energy (DOE) may be better able to allocate resources for data and program development. The document is divided into four chapters. Chapter I includes current and historic data on energy supply, demand, and production; sector fuel demands, fuel consumption, transmission, and transportation; location of energy production and conversion; and energy prices by sector and state. Chapter II shows a variety of natural and preternatural characteristics including water quality and quantity; air quality and air quality control areas; natural and induced climatic conditions; waste disposal; land and coast conditions, use, and management; managed and endangered species; demographic and socioeconomic conditions; and health and mortality data. Included in Chapter III are a variety of organizational, legislative, and regulatory data. Chapter IV provides energy equivalents, metric conversions, an index, and a glossary.

ASSESSMENT OF ENERGY TECHNOLOGIES

REFER ALSO TO CITATION(S) 3616, 3662

3617 (ORNL—5427, pp 39-59) **Technology assessments.** Rohwer, P.S.; Anderson, D.L.; Christian, D.J. Aug 1978.

In Health and Safety Research Division progress report for period ending April 30, 1978.

Theoretical studies in assessment methodology have concentrated in the past year on computerization of state-of-the-art models for internal radiation dosimetry and development and evaluation of environmental transport models. Methodology applications continued to cover a broad spectrum of radiation exposure scenarios. Potential exposure situations requiring assessment arise from assorted deployments of all parts of nuclear fuel cycles, including comparisons of alternative uranium and thorium based cycles, and preliminary evaluations of advanced reactor fuel concepts. Measurements and samples were collected characterizing and documenting the current radiological status of formerly used Manhattan Engineer District/Atomic Energy Commission (MED/AEC) sites. This survey program encompasses research activities in the areas of survey design, instrumentation development, sample analysis, and data reduction and analysis. Other laboratory activities within TAS center around the unique capabilities of the Health Physics Research Reactor (HPRR) as an irradiation source. Typically the HPRR was involved in testing and intercomparison of dosimetry and criticality alarm systems and in exposure of physical and biological experiments.

BIOMEDICAL SCIENCES, BASIC STUDIES

BEHAVIORAL BIOLOGY

REFER ALSO TO CITATION(S) 3639

BIOCHEMISTRY

REFER ALSO TO CITATION(S) 3633, 3636, 3639, 3652

3618 Role of the liver in regulating somatomedin activity: hormonal effects on the synthesis and release of insulin-like growth factor and its carrier protein by the isolated perfused rat liver. Schalch, D.S. (Univ. of Colorado Medical Center, Denver); Heinrich, U.E.; Draznin, B.; Johnson, C.J.; Miller, L.L. *Endocrinology;* **104**: No. 4, 1143-1151(Apr 1979).

Previous studies have indicated that one or more GH-dependent somatomedins (SMs) are either synthesized or released by the liver. Using the isolated rat liver profusion technique and a competitive protein-binding assay to measure one of the SMs [insulin-like growth factor (IGF)] and its carrier protein (CP), the net cumulative release of these peptides from normal and hypophysectomized (hypox) rat livers has been studied. These studies demonstrate the importance of the liver in effecting the release, and probably the synthesis, of the SM IGF and its CP. Furthermore, they indicate that these hepatic functions are under multihormonal control. Such data, though not definitive, suggest that the liver occupies a central role in the regulation of growth.

3619 Metabolism of ether-linked glycerolipids in cultures of normal and neoplastic rat respiratory tract epithelium. Scott, C.C.; Heckman, C.A.; Nettesheim, P.; Snyder, F. (Oak Ridge Associated Universities, TN). Contract EY-76-C-05-0033. *Cancer Res.;* **39**: 207-214(Jan 1979).

To study the mechanism of ether lipid accumulation which is characteristic of many tumors, we have compared the metabolism of lipids in primary rat tracheal epithelial cells and in a cell line derived from a benzo(a)pyrene-induced tumor. Growth of the primary epithelial cells in vitro resulted in the accumulation of alkyldiacylglycerols at levels (10% of total lipid) comparable to those found in the tumor cell line (B2-1). This class of ether lipids could not be detected in normal rat tracheal epithelium in vivo. A double isotope labeling method using [^{3}H]- and [^{14}C]palmatic acid was used to study metabolic stability of lipid classes in the cell cultures. Primary cells and B2-1 cells labeled with palmitic acid showed the greatest loss of label from triacylglycerols and free fatty acids during incubation in unlabeled media. A slight loss of label from the ester linkages of the alkyldiacylglycerols was observed in the primary epithelial cells but not the B2-1 cells. No label was lost from the ether linages of the alkyldiacylglycerols of either the B2-1 or primary cells. With the exception of diradlglycerophosphocholine, phospholipids of primary and B2-1 cells labeled with palmitic acid accumulated label during incubation in unlabeled media. Similar results were observed with the B2-1 cells using labeled glycerol as the lipid precursor. The results demonstrate that alkyldiacylglycerols can be induced in nontumorigenic cells by growth in culture and can thus provide a useful model for studying the regulation of ether lipid metabolism.

3620 /sup 123m/Te-labeled biochemicals and method of preparation. Knapp, F.F. Jr. (to Dept. of Energy). US Patent Application 920,411. 29 Jun 1978. 23p.

A novel class of /sup 123m/Te-labeled steroids and amino acids is provided by the method of reacting a /sup 123m/Te symmetric diorgano ditelluride with a hydride reducing agent and a source of alkali metal ions to form an alkali metal organo telluride. The alkali metal organo telluride is reacted with a primary halogenated steroidal side chain, amino acid, or amino acid precursor such as hydantoin. The novel compounds are useful as biological tracers and as organal imaging agents.

3621 Defluorination of fluoroacetate in vitro by rat liver subcellular fractions. Kostyniak, P.J. (State Univ. of New York, Buffalo); Bosmann, H.B.; Smith, F.A. *Toxicol. Appl. Pharmacol.;* **44**: 89-97(1978).

An earlier report showing enhanced accumulation of ionic fluoride in bones of rats given fluoroacetate (FAc) suggested an in vivo defluorination of fluoroacetate. Rat liver an organ which shows minimal pathological and biochemical effects in FAc intoxication was found to possess defluorination activity in vitro. Subcellular fractionation of livers from male Sprague-Dawley rats was performed in 0.25 M sucrose and yielded the following fractions: whole homogenate, nuclear, mitochondrial, microsomal and 105,000 g supernatant. Defluorination activity was measured by incubating subcellular fractions and their boiled controls with FAc (1 hr, 37°C, pH 7.4, in 0.1 m Tris-HCl or 0.1% Triton X-100) and comparing the difference in ionic fluoride content at the end of the incubation. Defluorination activity based on protein content was consistently the highest in the 105,000 g supernatant fraction, the only fraction showing an activity increase over the original homogenate. The microsomal fraction had minimal activity. Defluorination activity in the 105,000 g supernatant as a function of time after fraction isolation at 4°C revealed a time-dependent reduction in activity. After 24 hr at 4°C, activity was almost lost. The time-dependent loss of activity at 4°C could be regained when glutathione (GSH) was added to this fraction at a final concentration of 5 mm. Furthermore, GSH increased the defluorination activity in all subcellular fractions. A study of the optimum pH for defluorination activity in the 105,000 g supernatant fraction was performed in 0.1 m Tris-maleate buffer. A complete loss of activity with this buffer resulted throughout the pH range studied (pH 5.6 to 8.0). Furthermore, defluorination activity of all subcellular rat liver fractions was completely inhibited by maleate and stimulated by glutathione. Results are consistent with the involvement of a sulfhydryl group in the defluorination of FAc in rat liver.

3622 Role of pre-replication and post-replication processes in mutation induction in Haemophilus influenzae by N-methyl-N'-nitro-N-nitrosoguanidine. Kimball, R.F.; Perdue, S.W.; Boling, M.E. (Oak Ridge National Lab., TN). *Mutat. Res.;* **52**: 57-72(1978).

Studies were carried out on the repair and fixation of premutational damage induced in Haemophilus influenzae by N-methyl-N'-nitro-N-nitrosoguanidine (MNNG). The studies employed a temperature-sensitive DNA elongation mutant (dna9) and its combinations with mutants defective in pyrimidine dimer excision (uvr1, uvr2) and in recombination (rec1). The dna9 mutant is shown to be leaky, allowing about 1% of the normal rate of DNA synthesis at the restrictive temperature. Repair of premutational lesions was detected by a decline in mutation frequency with increasing delay in DNA replication in dna9 at the restrictive temperature. This repair is unaffected by the pyrimidine dimer excision system. Mutation fixation was detected by the ability of DNA from treated and then lysed cells to transfer mutants to recipient cells by transformation. Some fixation occurred at the restrictive temperature but much less than at the non-restrictive temperature suggesting that an appreciable minority of the mutations resulted from lesions introduced near the replication fork but that the majority of mutations arise from lesions introduced at some distance from the fork, perhaps randomly. The DNA synthesized immediately after MNNG treatment is of lower molecular weight than normal and returns to normal with time. This return is blocked in the rec1 mutant, suggesting that recombination is involved. The possible role of this process in MNNG mutagenesis is discussed.

3623 Selenium-sulfur analogues. I. Synthesis and biochemical evaluation of selenotetramisole. Hanson, R.N. (Northeastern Univ., Boston, MA); Giese, R.W.; Davis, M.A.; Costello, S.M. *J. Med. Chem.;* **21**: No. 5, 496-498(1978).

The compound (+-)-2,3,5,6-tetrahydro-6-phenylimidazo[2,1-b]selenazole (1-selenotetramisole) was prepared from 2-aminoselenazoline in a three-step synthetic sequence. Resolution with d-10-camphorsulfonic acid yielded the optical isomers which were compared with (+)- and (-)-tetramisole as inhibitors of alkaline phosphatase isoenzymes. At 8.7 x 10^{-5} M the (-) isomer of both tetramisole and 1-selenotetramisole produced significant inhibition of bovine

liver and placental isoenzymes but not of calf intestinal or human placental isoenzymes. The (+) isomers demonstrated no inhibition at these concentrations. The similarity in inhibitory activity of the (-) isomers indicates the virtual interchangeability of selenium for sulfur for sulfur in the thiazolidine ring of the parent drug and the likelihood that ^{75}Se-radiolabeled selenotetramisole can provide an in vivo tracer to tetramisole biodistribution.

3624 Conformational flexibility in DNA structure and its implications in understanding the organization of DNA in chromatin. Sobell, H.M.; Tsai, C.C.; Jain, S.C.; Sakore, T.D. (Univ. of Rochester, NY). *Philos. Trans. R. Soc. London, Ser. B;* **283**: 295-298(1978).

X-ray crystallographic studies of drug-nucleic acid crystalline complexes have suggested that DNA first bends or kinks before accepting an intercalative drug or dye. This flexibility in DNA structure is made possible by altering the normal C2′ endo deoxyribose sugar puckering in B DNA to a mixed sugar puckering pattern of the type C3′ endo (3′-5′) C2′ endo and partially unstacking base pairs. A kinking scheme such as this would require minimal stereochemical rearrangement and would also involve small energies. This has prompted us to ask more generally if a conformational change such as this could be used by proteins in their interactions with DNA. Here we describe an interesting superhelical DNA structure formed by kinking DNA every ten base pairs. This structure may be used in the organization of DNA within the nucleosome structure in chromatin.

3625 Crystallographic data on a complete k-type human Bence-Jones protein. Schiffer, M. (Argonne National Lab., IL); Westholm, F.A.; Panagiotopoulos, N.; Solomon, A. *J. Mol. Biol;* **124**: 287-290(1978).

A complete human k-type Bence-Jones protein (Fin) has been isolated and crystallized. Immunochemical and physicochemical characterization of protein Fin indicates that it is of the k-chain subgroup, kII, and that it consists of two non-covalently bound intact monomers having a molecular weight of about 23,000 crystals of Bence-Jones protein Fin obtained from ammonium sulfate solutions have the orthorhombic space group $P2_12_12_1$ with cell dimensions a = 132.0 A, b = 93.3 A, c = 42.3 A. The asymmetric unit consists of a dimer of molecular weight about 46,000.

3626 Characterization of HeLa 5′-nucleotidase: a stable plasma membrane marker. Brake, E.T. (Oak Ridge National Laboratory, TN); Will, P.C.; Cook, J.S. *Membrane Biochem.;* **2**: No. 1, 17-46(22 Nov 1977).

The enzyme 5′-nucleotidase, assayed as 5′-AMPase, has been extensively characterized and established as a stable, quantitative plasma membrane marker in HeLa S3 cells. The 5′-AMPase has a K/ sub m/ of 7.0 μm. There are activity optima at pH7 and 10; the latter is Mg^{2+}-dependent. The membrane preparations have a small amount of acid phosphatase activity that is distinct from 5′-AMPase activity but no alkaline phosphatase. ADP, ATP and α, β-methylene adenosine-5′-diphosphate are strongly inhibitory. Mg^{2+}, Ca^{2+}, or Co^{2+} do not affect the pH 7.0 activity; Mn^{2+} activates slightly, whereas Zn^{2+}, Cu^{2+}, and Ni^{2+} are inhibitory. EDTA slowly inactivates, but removal of the EDTA without the addition of divalent cations restores activity. The inactivation is also substantially reversed by Co^{2+} or Mn^{2+}. ConA strongly inhibits, and α-methyl-D-mannoside or glucose relieves the inhibition, indicating that the 5′-AMPase is a glycoprotein. Histidine is also inhibitory. Ouabain, phloretin, cytochalasin B, cysteine, phenylalanine, N-ethylmaleimide, and iodoacetic acid are without effect.

TRACER TECHNIQUES

REFER ALSO TO CITATION(S) 3620, 3656

CYTOLOGY

REFER ALSO TO CITATION(S) 3637

3627 Establishment of epithelial cell lines following exposure of cultured tracheal epithelium to 12-O-Tetradecanoyl-phorbol-13-acetate. Steele, V.E.; Marchok, A.C.; Nettesheim, P. (Oak Ridge National Lab., TN). *Cancer Res.;* **38**: 3563-3565(Oct 1978).

In vitro exposure of rat tracheal epithelium to the tumor-promoting agent 12-O-tetradecanoyl-phorbol-13-acetate results in a marked increase in growth capacity. The growth changes are manifested in an increased rate of cell division and growth in primary cultures and in the establishment of permanent epithelial cell lines. Such changes did not occur in control cultures. Fourteen of the cell lines have been inoculated into immunosuppressed recipients, and all are nontumorigenic.

GENETICS

REFER ALSO TO CITATION(S) 3645, 3650

3628 Somatic cells as indicators of germinal mutations in the mouse. Russell, L.B. (Oak Ridge National Lab., TN). *Environ. Health Perspect.;* **24**: 113-116(Jun 1978).

In attempts to find a prescreen for mutagens that may induce heritable mutations in mammals, an in vivo somatic mutation test has been developed in the mouse that uses a localized gene product (hair pigment), is relatively fast and cheap, and gives results that have some predictive value for point mutation induction in spermatogonia. Embryos heterozygous at specific coat color loci are exposed to the presumptive mutagen, and 3 weeks later the fur is observed for spots of altered color. It is possible to distinguish spots resulting from expression of the recessive (RS's) from spots having various other causes. In tests with seven compounds, mutation rates per locus and unit dose have been calculated on the assumption that 175 cells are at risk per 10 1/4-day embryo (a number derived from distribution of spot proportions). These rates are found to be roughly parallel to, but uniformly higher than spermatogonial point-mutation rates for the same seven compounds. The higher somatic rates are presumably due to the fact that RS's can result from several genetic mechanisms besides point mutations. The spot test, which has not to date given any false negatives, may thus be considered a useful in vivo prescreen for heritable germinal mutations in mammals.

METABOLISM

REFER ALSO TO CITATION(S) 3602, 3619, 3621

MEDICINE

REFER ALSO TO CITATION(S) 3623

3629 Treatment of transplanted murine tumors with an oncolytic virus and cyclophosphamide. Eiselein, J.E.; Biggs, M.W.; Walton, J.R. (Univ. of California, Livermore). *Cancer Res.;* **38**: 3817-3822(Nov 1978).

Effective treatment of transplanted murine mammary tumors with an oncolytic virus and cyclophosphamide is reported. The oncolytic virus was cultured initially from a murine ascites tumor that had undergone spontaneous regression. This virus used alone causes rapid lysis of ascites tumors, but successful treatment of solid tumors requires the addition of cyclophosphamide. The virus must be injected directly into the tumor. The virus causes no detectable disease in mice even when administered in conjunction with cyclophosphamide. Fluorescent antibody techniques revealed that all A/S stock mice have antibody against cells infected with this virus.

UNSEALED RADIONUCLIDES IN DIAGNOSTICS

3630 (ORNL—5427) Health and Safety Research Division progress report for period ending April 30, 1978. Kaye, S.V. (Oak Ridge National Lab., TN (USA)). Aug 1978. Contract W-7405-ENG-26. 102p. Dep. NTIS, PC A06/MF A01.

The research goal of the Health and Safety Research Division is to conduct basic and applied research that contributes new scientific knowledge with emphasis in biophysical areas that lead to a better understanding of how alternative energy-related technologies affect man. Included in the basic research are fundamental processes that are important to understand formation, mobility, toxicity, detection, and characterization of pollutants. The applied research includes the integration of data from basic and applied studies through development of concepts and methodologies that can be used for energy-related assessments with primary focus on the health and safety of man. The division has no responsibilities for on-site health and safety.

3631 (ORNL—5427, pp 21-25) Biomedical effects and instrumentation. Poggenburg, J.K.; Ambrose, K.R.; Becker, J.M. Aug 1978.

In Health and Safety Research Division progress report for period ending April 30, 1978.

The section's research programs, which are focused on improving man's health and safety, are concerned with the promotion of beneficial nuclear applications through the development of new radiopharmaceuticals for diagnosis or therapy and the assessment of risk and protection of man from harmful effects of radiation and chemical insults. Methodologies for quantifying radiation dose to organs are developed from metabolic models and Monte Carlo transport calculations. These are correlated with population studies and observed health effects for the development of risk factors and appropriate exposure limits. The implications of new energy technol-

ogies are assessed for their impact on human health with effort toward developing appropriate dose concepts and risk factors for nonnuclear technologies. Protection of workers is sought through the development of advanced instrumentation with increased sensitivity for rapid detection of polynuclear aromatics and other chemical hazards in the work environment.

3632 Multiple-image oscilloscope camera. Yasillo, N.J. (to Dept. of Energy). US Patent 4,103,310. 25 Jul 1978. Filed date 27 Jan 1977. 4p.
PAT-APPL-763,166.

An optical device for placing automatically a plurality of images at selected locations on one film comprises a stepping motor coupled to a rotating mirror and lens. A mechanical connection from the mirror controls an electronic logical system to allow rotation of the mirror to place a focused image at tge desired preselected location. The device is of especial utility when used to place four images on a single film to record oscilloscope views obtained in gamma radiography.

EXTERNAL RADIATION IN DIAGNOSTICS

REFER ALSO TO CITATION(S) 3646

MICROBIOLOGY

REFER ALSO TO CITATION(S) 3622, 3629, 3645, 3652, 3664

3633 Kynureninase-type enzymes from two strains of Xanthomonas pruni. Shetty, A.S.; Gaertner, F.H. (Florida A and M Univ., Tallahassee). *FEMS Microbiol. Lett.;* **3**: 259-263(1978).

The tryptophan to nicotinamide adenine dinucleotide (NAD) pathway in Xanthomonas pruni was studied to determine if that bacterium is an example of an organism containing a physiologically functional kynureninase-hydroxykynureninase. Results confirm the presence of a kynureninase-type enzyme in X. pruni. No niacin dependency was demonstrated. X. pruni utilizes the tryptophan pathway for its de novo source of endogenously synthesized NAD. Since it has the ability to synthesize NAD from L-tryptophan, yet appears to contain only a single kynureninase-type enzyme (which is inducible and has a relatively low Km for L-kynurenine), it was concluded that the organism must use this activity for the purpose of degrading L-tryptophan (via anthranilate) to other catabolites as well. The dual physiological function is supported by the fact that when the organism is grown with L-tryptophan, anthranilate is excreted. When it is grown in medium containing L-3-hydroxykynurenine, 3-hydroxyanthranilate is excreted. It was hypothesized that in the course of evolution, at some point a kynureninase-type activity with a dual role must have occurred in other microorganisms. The possibility that X. pruni may be an extant example of such a primordial prototype is suggested by the data.

MORPHOLOGY

REFER ALSO TO CITATION(S) 3637

PATHOLOGY

REFER ALSO TO CITATION(S) 3637, 3639, 3669

3634 (COO—0910-48) **Bovine lymphocytic leukemia: studies of etiology, pathogenesis, and mode of transmission. Progress report No. 19, June 1978-June 1979.** Sorensen, D.K. (Minnesota Univ., St. Paul (USA). Coll. of Veterinary Medicine). Jul 1979. Contract EY-76-S-02-0910. 13p. Dep. NTIS, PC A02/MF A01.

Bovine leukemia is believed to be caused by an oncogenic RNA virus designated bovine leukemia virus (BLV). The presence of BLV particles in lymphocyte cultures from leukemic cattle and cattle with a persistent lymphocytosis has been consistentily demonstrated. Concentrated, cell free, BLV preparations were used to inoculate 12 late stage bovine fetuses (in utero) and two newborn calves. Current studies involve extensive monitoring of these inoculated animals to detect precancerous changes and obtain a detailed description of the events preceding the development of lymphosarcoma. Ongoing monitoring studies will provide a complete record of all changes in the various leukemia associated parameters. We will then be able to detail when, in what sequence, and to what extent each parameter changes in the course of lymphosarcoma development. Fourteen animals were successfully inoculated during the study. Eleven remain alive, and comprise the current monitoring program. All eleven of these animals are definitely infected with BLV, and in nine the infection has substantially progressed with respect to the parameters being monitored. In addition to transmission and monitoring studies, various lymphocyte subpopulations were examined to determine which cell type(s) are involved in the pathogenesis of bovine lymphosarcoma. These studies have conclusively established that B-lymphocytes are the target cells for BLV infection and that they carry the morphologic nuclear abnormality associated with this disease.

3635 (COO—0910-51) **Prevalence and economics and bovine leukosis in the United States.** Sorensen, D.K.; Beal, V.C. Jr. (Minnesota Univ., St. Paul (USA). Coll. of Veterinary Medicine; Animal and Plant Health Inspection Service, Hyattsville, MD (USA)). 1979. Contract EY-76-S-02-0910. 18p. (CONF-7905116—2). Dep. NTIS, PC A02/MF A01.

From Bovine leukosis symposium; College Park, MD, USA (22 May 1979).

This paper reviews the prevalence of bovine leukosis in the US and discusses the economic significance of the disease. The term leukosis is used except when reporting the Meat Inspection Department data which used the term malignant lymphoma instead. (PCS)

PHYSIOLOGICAL SYSTEMS

REFER ALSO TO CITATION(S) 3602, 3618

3636 Proposed mechanism(s) of transitory ischemic injury to myocardium. Schneider, M.D.; Kelman, B.J. (Comparative Animal Research Lab., Oak Ridge, TN). *Am. J. Vet. Res.;* **40**: No. 2, 170-182(1979).

The main objective of this study was to produce primary acute ischemic injury to myocardium in a live animal. In vitro, guinea pig platelets were sensitive to perturbation and aggregation by a suspension of ultrafine fibrillary collagen material isolated from the aorta of an aged burro (Equus asinus). The platelets responded to this material down to 100 to 200 ng (dry weight) added to 0.45 ml of platelet-rich plasma, as determined by aggregometric technique. Aortic fibrillary collagen material injected IV into guinea pigs circulating platelets within 5 minutes. In blood samples taken 2.5 hours after injection, 50 to 75% of control levels of platelets were found. In other experiments, 3 anesthetized animals were injected by jugular vein with active fibrillary collagen material. Two control animals were injected with the same dose of the material that had been inactivated (15 minutes at 100 C). Intraventricular pressures and electrocardiographs (ECG) were monitored continuously for the first 30 minutes. The injection of the active fibrillary collagen material caused a large ventricular pressure elevation in approximately 40 s. Within 60 s, there was a reduction in the absolute platelet number in the peripheral circulation. The elevation of ventricular pressure persisted for approximately 5 minutes and was followed within 30 minutes by a set of ECG events suggestive of acute myocardial ischemic injury. The ECG changes seemed to be subsequent to platelet microthrombus formation in the pulmonary arterial microcirculation. By 2.5 hours after the treatment, platelets rebounded into the circulation in 2 surviving guinea pigs, and left ventricular pressures and ECG profiles returned to the preinfusion base lines. Guinea pigs IV infused with similar amounts of inactivated fibrillary collagen material did not show changes.

3637 (CONF-790922—2) **Endocrine morphology and reproductive function in athymic rude mice.** Davidson, K.A.; Holland, J.M.; Hall, J.W.; Gipson, L.C. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG=26. 17p. Dep. NTIS, PC A02/MF A01.

From Workshop on nude mice; Bozeman, MT, USA (6 Sep 1979).

Athymic BALB/c nude mice were reared and maintained in a specific pathogen-free (SPF) environment in order to assess the impact of genetic athymia on endocrine morphology and reproductive performance. Mice were killed at 4, 8, 12, 16, and 19 weeks of age. Kidneys, testes, ovaries, adrenals, thyroid, and submaxillary gland were processed for histology. Plasma content of estradiol (females) and testosterone (males) was determined. Plasma levels of estradiol and testosterone were comparable in nude and normal mice. The morphology of the ovaries of nude females was similar to normal females although fewer nude females (42%) had corpora lutea at 8 weeks than normal females (84%). Degeneration of the adrenal x-zone was slightly retarded in nude females. The thyroid gland was normal in nude mice; age related changes were observed in both phenotypes. Sexual dimorphism was observed in the morphology of the kidney and submaxillary glands in nude males. The appearance of these dimorphic characteristics corresponded with the appearance of mature spermatozoa in the seminiferous tubules of the testes (8 weeks). Male and female nude mice were fertile, however, the survival of young to weaning was less in litters from nude females (28%) than from normal females (42%). These results suggest that abnormalities in endocrine morphology and reproductive

performance are less severe in nude mice reared and maintained in SPF environment than those reported by other investigators.

3638 Effects of cadmium ingestion in rats with opposite genetic predisposition to hypertension. Ohanian, E.V.; Iwai, J. (Brookhaven National Lab., Upton, NY). *Environ. Health Perspect.;* **28**: 261-266(Feb 1979).

This study was undertaken to explore the effects of chronic low-level cadmium ingestion in Dahl hypertension-resistant (R) and hypertension-sensitive (S) lines of rats. Groups of weanling female R and S rats were given 0 or 1 mg cadmium/l in drinking water and fed either a low salt (0.4% NaCl) or a high salt (4% NaCl) diet for 28 weeks. Cadmium produced hypertension associated with gross cardiac hypertrophy and mild to moderate renal vascular changes in S, but not in R, rats on a low salt diet. Cadmium enhanced the rate and degree of development of salt-induced hypertension without the hypercholesterolemia or renal vascular lesions normally observed in S rats on a high salt diet. Cadmium lowered circulating cholesterol levels in both lines on a low salt diet. Cadmium had no influence on growth, blood urea nitrogen concentration, plasma renin activity, tumor formation, or survivorship in R and S rats on either salt diet. This study indicates that the genetic composition is a critical determinant of the adverse effects of chronic low-level cadmium ingestion in rats. In addition to the experimental implications, these findings may have relevance to the problem of human essential hypertension.

3639 (JPRS—74470) **Space biology and aerospace medicine.** Translated from *Kosm. Biol. Aviakosmicheskaya Med.;* **13**: No. 5, 3-90(1979). 145p. NTIS.

The report contains articles concerning the selection and training of cosmonauts; evaluation and analysis of accumulated data to facilitate the on-going transition from orbital to interplanetary flights; research aimed at guaranteeing safety on long flights and reliability of the human component of the man-spaceship system; space psychology and physiology; environmental problems and control (spacecraft habitability, effects of radiation and weightlessness, etc.) and telemetry. Twenty-four papers by individual authors are included.

3640 Snap harness for biotelemetry from rodents. Roman, B.; Bennett, E.L. (Univ. of California, Berkeley). *Physiol. Behav.;* **20**: 349-350(1978).

A snap harness is described which incorporates a commercially built 5g FM transmitter (FM-110-E3) (Narco Bio-Systems, Inc., Houston, TX) for telemetering biopotentials in rats and other small rodents. The harness allows the stable recording of a variety of biopotentials from unanesthetized freely moving animals for experimental periods of a few weeks. There is the added advantage and flexibility of easily snapping the harness on and off during and after experimental periods, permitting recordings from a number of animals with the same transmitter.

3641 Application of the chemiosmotic hypothesis to ion transport across the root. Hanson, J.B. (Univ. of California, Davis). *Plant Physiol.;* **62**: 402-405(1978).

The evidence on how ions accumulated in the root symplasm are released to the xylem vessels is examined. It is suggested that Mitchell's chemiosmotic hypothesis as applied to ion transport might account for the process. A model based on this hypothesis shows the symplasm as an osmotic unit connecting two isolated solutions, but with no significant difference in proton motive force across the unit. If it is assumed that the resistance to transport by plasmalemma uniports and antiports differs in the cortical and stelar ends of the symplasm, the model will provide for an influx of ions to the xylem. The reported properties of isolated steles suggests that the porters (carriers) do have properties in accord with the model.

AGRICULTURE AND FOOD TECHNOLOGY

REFER ALSO TO CITATION(S) 3635

3642 (LA—7844-PR) **Computer applications. Annual report, October 1, 1977-September 30, 1978.** Sanders, W.M.; Campbell, C.L.; Lester, J.V.; Payne, R.J. (Los Alamos Scientific Lab., NM (USA)). Sep 1979. Contract W-7405-ENG-36. 30p. Dep. NTIS, PC A03/MF A01.

The Los Alamos Scientific Laboratory is funded by the US Department of Agriculture to apply scientific and computer technology to solve agricultural problems. This report summarizes work during the period October 1, 1977, through September 30, 1978, on the application of computer technology to three areas: (1) surveillance of slaughterplants in Texas; (2) a pilot study of the New Mexico Brucellosis Eradication Program; and (3) the Market Cattle Identification program in Texas.

3643 (UCID—18174-79-2) **Mutagens from the cooking of food. Semiannual progress report, March 1-September 30, 1979.** Mendelsohn, M.L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1 Nov 1979. Contract W-7405-ENG-48. 74p. Dep. NTIS, PC A04/MF A01.

The objectives of this study are as follows: to determine the nature and mechanism of formation of the mutagens formed during the cooking of foods; to quantify mutagen formation; to assess the spectrum of genetic toxicity of the mutagens; to estimate the risk to the human population posed by the ingestion of mutagens derived from the cooking of foods; and to devise strategies to control or prevent mutagen formation. In the first year of the study, progress was made in the following areas: confirmed reports that bacterial mutagens are formed during cooking of hamburger; obtained an increased yield of mutagens by acetone extraction of meat; found that the mutagens are almost exclusively in an alkaline aromatic fraction; found the mutagens to be highly specific for Salmonella strains sensitive to frameshift mutations; studied the metabolic activation of food mutagens by liver homogenate systems; conducted a survey of grilling hamburger on various cooking surfaces, showing marked differences in mutagen formation; demonstrated with boiled beef that the mutagens arise from water soluble, low molecular weight components after prolonged heating; found greater mutagen formaton when beef extract is boiled in stainless steel than in glass; observed enhancement of mutagen formation in boiled beef at acidic and alkaline pH compared to neutral pH; initiated syntheses of labeled mutagenic organic amines, with studies of their pharmacokinetics in rats; analyzed the two largest data bases on the American diet for the principal sources of cooked protein foods; made preliminary calculations which indicate that daily ingestion of 100 g of grilled or fried beef might account for a significant fraction of the incidence of intestinal cancer in man. (ERB)

BIOMEDICAL SCIENCES, APPLIED STUDIES

REFER ALSO TO CITATION(S) 3630

RADIATION EFFECTS ON CELLS

REFER ALSO TO CITATION(S) 3647

EXTERNAL SOURCE

REFER ALSO TO CITATION(S) 3548

INTERNAL SOURCE

3644 Progression of ^{226}Ra-induced ocular alterations in beagles. Momeni, M.H.; Muggli, F.M. (Argonne National Lab., IL). Contract AT(04-3)-472. *Ophthalmic Res.;* **9**: 112-122(1977).

The temporal progression of ocular injury involving the iris and tapetum lucidum in beagles injected with ^{226}Ra was quantitated by assigning subjective numerical indices. Concentration of radium in melanotic ocular tissue was measured by an autoradiographic technique. The observed changes consisted of iris hyperpigmentation, depigmentation and progressive tapetal loss. Each change was dependent on the injected radium activity and on the time after injection. At higher radium levels iris depigmentation progressed centrally and peripherally, exposing fibrillar structural elements. Tapetal alteration progressed initially from a granular or finely stippled pattern to pigmented foci interspersed between hyporeflective tapetum and finally to a complete loss of tapetum and exposure of the choroidal vasculature. The average radiation dose from injections of 28.1 and 83.6 μCi ^{226}Ra to ocular pigmented tissues integrated for 5 years was estimated at 150 and 460 rad, respectively. An injection of 0.18 μCi ^{226}Ra did not induce an ocular alteration within 10 years of follow-up.

RADIATION EFFECTS ON MICROORGANISMS

BASIC STUDIES

3645 (COO—4964-1) **Inducible error-prone repair in B. subtilis. Progress report, September 1, 1978-August 31, 1979.** Yasbin, R.E. (Pennsylvania State Univ., University Park (USA). Dept. of Microbiology and Cell Biology). 1979. Contract EP-78-S-02-4964. 15p. Dep. NTIS, PC A02/MF A01.

The mechanism of activation and the mode of action of the SOS system in the bacterium Bacillus subtilis is under study. Interesting aspects of the SOS system in B. subtilis are: (1) the differences between SOS functions in this bacterium and in the enteric bacteria; (2) the spontaneous activation of SOS functions in component cells.

and (3) the difficulty in obtaining consistent results for mutation studies in this bacterium. In order to characterize the SOS system of B. subtilis, it was proposed to: (1) isolate bacteria mutated in genes controlling various repair function; (2) investigate inducible repair; (3) determine the role of endogeneous Bacillus prophages in SOS functions; and (4) develop a tester system for potential carcinogens from competent Bacillus subtilis cells. Research has been able to: (1) isolate strains of B. subtilis in which the endogeneous prophages have been removed or neutralized; (2) demonstrate the association of one SOS function with prophage SPB; (3) demonstrate that the survival of uv-irradiated B. subtilis is not significantly altered by the removal and neutralization of the endogeneous prophages; (4) develop competant B. subtilis into a tester system; and (5) show that DNA polymerase III is absolutely necessary for W reactivation. In addition, uv and mitomycin C resistant mutants have been isolated and inducible postreplication repair in excision-repair deficient mutants of B. subtilis has been studied. The last two results are somewaht confusing but highly exciting in regards to DNA repair mechanisms in B. subtilis.

RADIATION EFFECTS ON ANIMALS

MAN

REFER ALSO TO CITATION(S) 2680, 3590, 3617, 3631, 3632, 3639

3646 (LBL—9738) **Heavy particle clinical radiotherapy trial at Lawrence Berkeley Laboratory. Progress report, July 1975-July 1979.** Castro, J.R. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). 1979. Contract W-7405-ENG-48. 16p. Dep. NTIS, PC A02/MF A01.

The primary objectives of the clinical radiotherapy program are: to evaluate the potential of improved dose localization particularly as exemplified by helium ion irradiation; and to evaluate the combined potential of improved dose localization and increased biologic effect available with heavier ions such as carbon, neon, and argon. It was possible to make modifications rapidly to provide for large field, fractionated, Bragg peak irradiation at the 184-inch cyclotron with the helium ion beam. This allowed the opportunity to gain experience with charged particle irradiation treatment techniques, patient immobilization techniques, treatment planning and dosimetry studies including the utilization of CT scanning for tumor localization and charged particle dose distributions as well as beginning studies in compensating for tissue inhomogeneities in the beam path. These treatment techniques have been directly transferable to the Bevalac facility where a similar patient positioner has been installed for human irradiation with heavier particles. For the studies both with helium and now with heavier particles, patients with multiple skin and subcutaneous metastatic nodules for evaluation of skin RBE data and patients with locally advanced and/or unresectable tumors unlikely to be effectively treated by any conventional modality were sought. In order to facilitate intercomparison with megavoltage irradiation techniques, a conventional dose fractionation scheme has been adopted. A few exceptions to this dose specification scheme have been patients in which pulmonary, subcutaneous or skin nodules have been irradiated with larger fraction sizes ranging up to 400 rads per fraction in order to obtain clinical RBE studies in 8 to 10 fractions of heavy particles.

VERTEBRATES

REFER ALSO TO CITATION(S) 3548

3647 **Neoplastic transformation induced by a direct perturbation of DNA.** Barrett, J.C.; Tsutsui, T.; Ts'o, P.O.P. (Johns Hopkins Univ., Baltimore, MD). *Nature (London);* **274**: 229-232(20 Jul 1978).

Treatment of Syrian hamster embryo cells with 5-bromodeoxyuridine followed by near ultraviolet irradiation results in neoplastic transformation of these cells. This demonstrates that a direct perturbation of DNA is sufficient to initiate neoplastic transformation.

NUCLIDE KINETICS AND TOXICOLOGY

MAN

REFER ALSO TO CITATION(S) 2680, 3492

ANIMALS

3648 (COO—4369-2) **Mixed ligand chelate therapy for plutonium and toxic metals from energy power production. Progress report, October 15, 1978-October 14, 1979.** Schubert, J. (Hope Coll., Holland, MI (USA). Div. of Natural Sciences). 12 Jul 1979. Contract EE-77-S-02-4369. 18p. Dep. NTIS, PC A02/MF A01.

It is shown that a mixed ligand chelate (MLC) is superior to that of the primary chelate alone for the decorporation of monomeric plutonium. Thus, EDTA plus Tiron reduces the level of Pu in the skeleton to about 40% less than that of EDTA alone when treatment was begun two hrs post ^{239}Pu. However, DTPA alone was still superior to EDTA/Tiron under the given experimental conditions. However, this appears to be due to the rapid metabolic destruction of secondary chelants such as Tiron and similar bidentate derivatives of catechol and salicylates. Investigations are under way to improve such MLC's by the use of metabolic inhibitors to increase the plasma concentrations and residence times of the secondary chelants. In addition, MLC's consisting of metabolically stable chelants are undergoing testing. Therapy of cadmium poisoned mice by single and mixed chelants is also under study. A molar ratio of EDTA to Cd of 1.6 reduces the mortality by half of female mice given 5 min (i.p.) post supralethal doses of $CdCl_2$, while a molar ratio of 4.7 for 2, 3-dimercaptopropanol-1-sulfonate (DMPS) is required. No protection is observed with penicillamine (PA) or salicylates (SA) alone. However, combinations of EDTA with both PA and DMPS or SA and DMPS afford protection under conditions (30 min post Cd) where the individual chelants are ineffective. Automated potentiometric titrations are utilized to detect MLC formation and to evaluate their stability. The titration data are used as a screening procedure to ascertain whether a given chelant combination is worth testing in vivo.

THERMAL EFFECTS

MICROORGANISMS

3649 (NTIS/PS—79/0257) **Thermal pollution. Part 2. Biological effects. Volume 2. 1974-February, 1979 (a bibliography with abstracts). Report for 1974-February 1979.** Brown, R.J. (National Technical Information Service, Springfield, VA (USA)). Apr 1979. 247p. NTIS PC N01/MF N01.

Abstracts covering the effects of heated effluents on fish, shellfish, microorganisms, and plants in both fresh and salt water are presented, including the effects on growth, ecology, metabolism, heat tolerance, and productivity. The effluent sources are both power and industrial plants.

PLANTS

REFER ALSO TO CITATION(S) 3649

INVERTEBRATES

REFER ALSO TO CITATION(S) 3649

VERTEBRATES

REFER ALSO TO CITATION(S) 3649

CHEMICALS METABOLISM AND TOXICITY

REFER ALSO TO CITATION(S) 3665, 3666

CELLS

REFER ALSO TO CITATION(S) 3619

3650 (UCID—18080-79-1) **Mutagenesis testing with mammalian cells: validating and adapting a multiple-marker bioassay to activate and detect mutagens in crude samples for energy technology. Progress report, January-June 1979.** Carver, J.H.; Hatch, F.T. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 9 Oct 1979. Contract W-7405-ENG-48. 37p. Dep. NTIS, PC A03/MF A01.

A Chinese hamster ovary (CHO) cell line heterozygous at both the adenine phosphoribosyltransferase (aprt) and thymidine kinase (tk) loci was used for single-step selection of spontaneous and induced mutants resistant to 8-azaadenine, 6-thioguanine, ouabain, or 5-fluorodeoxyuridine. Mutation data are reported for direct mutagens and promutagens activated by rat liver homogenates. The induced mutant frequencies as a function of relative cell survival after treatment with EMS, DMN, or BP showed locus-specific differences in sensitivity. A very high percentage of the spontaneous and induced drug-resistant clones scored as mutants had substantially diminished enzyme activity at the selected locus. The tk locus showed the largest mutational response. The rapid expression kinetics for FUdR/sup r/ and the possibility that the locus detects a broader spectrum of genetic lesions than the other drug-resistance markers are discussed in terms of a sensitive screening assay for detecting potential mutagens. Four carcinogens were identified as

mutagens, and two non-carcinogens were not mutagenic in the system. Two reported non-carcinogens were identified as mutagenic in the system. Four carcinogens that are reported to give negative or erratic results in Salmonella and/or cell transformation assays were negative also in this system. Ethylenethiourea failed to give the expected positive result when tested in this system. To solve the solubility problems encountered with compounds in the International Program, protocols were developed to allow higher concentrations of mutagen exposure by means of dispersal in corn oil emulsions. The techniques are currently being applied to studies on trichlorethylene. (ERB)

MICROORGANISMS

REFER ALSO TO CITATION(S) 3622, 3643, 3645

3651 (EPA—600/1-78-013) **Reviews of the environmental effects of pollutants. I. Mirex and Kepone.** Bell, M.A.; Ewing, R.A.; Lutz, G.A. (Battelle Columbus Labs., OH (USA)). Jul 1978. Contract W-7405-ENG-26. 252p. Dep. NTIS, PC A12/MF A01.

The publicly-available information on the environmental effects of the two organochlorine pesticides, Mirex and its ketone analog, Kepone, are assembled and analyzed. The data base on these compounds is limited, especially with respect to Kepone, on which almost no environmental research was conducted prior to the Life Science's Products Company incident. Both of these compounds are non-volatile, have very low water solubilities, are chemically and thermally very stable, and are quite resistant to biodegradation. Neither Mirex nor Kepone appreciably affects microorganisms or plants in usual environmental concentrations. Mirex does not appear to present a serious acute toxicity problem to non-target terrestrial invertebrates as a result of fire ant control efforts. Both Mirex and Kepone produce adverse reproductive effects in numerous species. Mirex has been shown to induce liver tumors in mice and rats and is judged to have potential carcinogenicity. The carcinogenic properties of Kepone have been documented in mice and rats. Both Mirex and Kepone are lipid-soluble and accumulate in fatty tissues, from which the rate of excretion is slow. Mirex has been detected in adipose tissues of humans and in beef fat from cattle in areas aerially treated for fire ant control, but there are few definitive data on its effects on humans, and exposures appear to have been minimal. Exposure of humans to Kepone in roach and ant traps appears also to have been minimal. Excessive exposures did result from the inadequate control of Kepone during its manufacture at LSPC. No practical scheme for the removal or neutralization of the Kepone contained in James River sediments downstream of this plant have yet been devised, and this environmental inventory is likely to pose a problem for many years.

3652 (SRO—0890-T1) **Interactions between arsenic species and marine algae.** Sanders, J.G. (North Carolina Univ., Chapel Hill (USA)). 1978. Contract EY-76-S-09-0890. 87p. Dep. NTIS, PC A05/MF A01.

Thesis.

The arsenic concentration and speciation of marine algae varies widely, from 0.4 to 23 $ng.mg^{-1}$, with significant differences in both total arsenic content and arsenic speciation occurring between algal classes. The Phaeophyceae contain more arsenic than other algal classes, and a greater proportion of the arsenic is organic. The concentration of inorganic arsenic is fairly constant in macro-algae, and may indicate a maximum level, with the excess being reduced and methylated. Phytoplankton take up As(V) readily, and incorporate a small percentage of it into the cell. The majority of the As(V) is reduced, methylated, and released to the surrounding media. The arsenic speciation in phytoplankton and Valonia also changes when As(V) is added to cultures. Arsenate and phosphate compete for uptake by algal cells. Arsenate inhibits primary production at concentrations as low as 5 $\mu g.l^{-1}$ when the phosphate concentration is low. The inhibition is competitive. A phosphate enrichment of > 0.3 μM alleviates this inhibition; however, the As(V) stress causes an increase in the cell's phosphorus requirement. Arsenite is also toxic to phytoplankton at similar concentrations. Methylated arsenic species did not affect cell productivity, even at concentrations of 25 $\mu g.l^{-1}$. Thus, the methylation of As(V) by the cell produces a stable, non-reactive compound which is nontoxic. The uptake and subsequent reduction and methylation of As(V) is a significant factor in determining the arsenic biogeochemistry of productive systems, and also the effect that the arsenic may have on algal productivity. Therefore, the role of marine algae in determining the arsenic speciation of marine systems cannot be ignored. (ERB)

PLANTS

REFER ALSO TO CITATION(S) 3605, 3651, 3667

3653 (ORNL/TM—6791) **Some sensitivity studies of chemical transport simulated in models of the soil-plant-litter system.** Begovich, C.L.; Luxmoore, R.J. (Oak Ridge National Lab., TN (USA)). Sep 1979. Contract W-7405-ENG-26. 107p. Dep. NTIS, PC A06/MF A01.

Fifteen parameters in a set of five coupled models describing carbon, water, and chemical dynamics in the soil-plant-litter system were varied in a sensitivity analysis of model response. Results are presented for chemical distribution in the components of soil, plants, and litter along with selected responses of biomass, internal chemical transport (xylem and phloem pathways), and chemical uptake. Response and sensitivity coefficients are presented for up to 102 model outputs in an appendix. Two soil properties (chemical distribution coefficient and chemical solubility) and three plant properties (leaf chemical permeability, cuticle thickness, and root chemical conductivity) had the greatest influence on chemical transport in the soil-plant-litter system under the conditions examined. Pollutant gas uptake (SO_2) increased with change in plant properties that increased plant growth. Heavy metal dynamics in litter responded to plant properties (phloem resistance, respiration characteristics) which induced changes in the chemical cycling to the litter system. Some of the SO_2 and heavy metal responses were not expected but became apparent through the modeling analysis.

3654 (SNV-PM—1191) **Survey of regional heavy metal concentrations in moss.** Ruehling, A.; Skaerby, L. (Statens Naturvaardsverk, Solna (Sweden)). May 1979. 28p. (In Swedish). Dep. NTIS (US Sales Only), PC A03/MF A01.

Samples were taken from 1000 locations in Sweden. Of these, 670 were analyzed for the content of Cd, Cu, Ni, Pb, V, and Zn. The results are given in the form of maps. In general, the concentrations did not vary drastically, but some high local concentrations were found at regions of metal mining activities.

INVERTEBRATES

REFER ALSO TO CITATION(S) 3651

3655 (ORNL—5427, pp 1-19) **Biological and radiation physics.** Wright, H.A.; Adkisson, M.J.; Allen, J.D. Aug 1978.

In Health and Safety Research Division progress report for period ending April 30, 1978.

Activities within this section consist primarily of basic physics research studies directed toward providing new scientific knowledge of the fundamental properties of matter in all phases (gas, liquid, and solid) and of processes and mechanisms important in the interaction of pollutants with the environment and with biological materials. A new program in Studies of Physical Parameters for Health Protection from Chemical Pollutants represents a redirection of our former analytic dosimetry effort which is being phased out. High Voltage Research dealing with the development of superior gaseous and liquid dielectrics for energy conservation during electrical energy distribution has been substantially increased this year. The acquisition of a new scanning electron microscope has been a very useful addition to our Submicron Physics Program. The first measurement of a surface potential at the atomic level was achieved this year in this program. The surface potential is responsible for the agglomeration of charged aerosol particles and their adhesion to surfaces and filters. Very accurate measurements of the shapes of the soft x-ray absorption and emission edges of the alkali metals lithium and sodium were made by members of our Physics of Solids and Macromolecules Group. These measurements were sufficiently accurate and complete to resolve long-standing debates in the literature. Collaboration between members of our Transport and Surface Physics Group and the Swiss Institute of Nuclear Research (SIN) continued in setting up a program for radiotherapy with pion beams. We have calculated electron interaction probabilities in polystyrene. This represents the first construction of such data for plastics and organic insulators.

VERTEBRATES

REFER ALSO TO CITATION(S) 3628, 3638, 3643, 3648, 3651, 3666, 3667

3656 (COO—3139-33) **Embryo culture in teratological surveillance and serum proteins in development. Progress report, 1978-1979.** Klein, N.W. (Connecticut Univ., Storrs (USA). Dept. of Animal Genetics). 1979. Contract EY-76-S-02-3139. 5p. Dep. NTIS, PC A02/MF A01.

Two initial studies on the use of cultured rat embryos for teratological surveillance have been completed using cadmium and cyclophosphamide teratogens. It was found that rat embryos could be cultured successfully on human serum supplemented with glucose, allowing testing to extend to human subjects. Tests using energy-related fuel substances (petroleum crude; shale oil; two coal-derived oils) implied possible long-term growth-inhibition effects for petroleum and coal but not for shale oil which was only shown to be teratogenic. (PCS)

3657 (COO—3140-3) **Toxicology and metabolism of nickel compounds. Progress report, December 1, 1978-November 30, 1979.** Sunderman, F.W. Jr. (Connecticut Univ., Farmington (USA). School of Medicine). 15 Aug 1979. Contract EY-76-S-02-3140. 20p. Dep. NTIS, PC A02/MF A01.

The toxicology and metabolism of nickel compounds were investigated in rats and hamsters. The new knowledge includes; demonstration that nickel carbonyl is teratogenic for hamsters; elucidation of physiological factors which influence αNi_3S_2-induced erythrocytosis in rats; development of a sensitive assay for heme oxygenase activity in renal microsomes for use in studies of renal effects of nickel compounds; demonstration that administration of $Ni(CO)_4$ to rats inhibits incorporation of ^{3}H-thymidine into DNA during hepatic regeneration; demonstration that clones of Syrian hamster fetal cells which have been transformed by in vitro exposure to αNi_3S_2 consistently cause sarcomas following sc injection into nude mice; demonstration that nickel carbonyl-cyclopentadiene dimer induces rhabdomyosarcomas following im injection in rats; observation of differences in carcinogenic activities of several insoluble nickel compounds; discovery that intraocular injection of αNi_3S_2 induces amelanotic melanomas in rats; and refinement of analytical methods for nickel in biological materials.

3658 (COO—10100-02) **Study of the mechanism of carcinogenesis by carcinogens which are negative in the Ames test. Progress report, April 1-September 1, 1979.** (American Cancer Research Center and Hospital, Lakewood, CO (USA)). 1979. Contract AC02-79EV10100. 10p. Dep. NTIS, PC A02/MF A01.

Carcinogens ethionine, thioacetamide, and actinomycin D, all of which are negative in the Ames test and all of which raise the progesterone level in the chicken, were tested to determine their physiological role in carcinogenesis. The optimization of the carcinogenesis model also included evaluation of the chicken as the biological indicator of physiological changes relative to the above compounds. (PCS)

3659 (LA—8037-MS) **Preliminary toxicological study of Irganox 1010.** Drake, G.A.; London, J.E.; Smith, D.M.; Thomas, R.G. (Los Alamos Scientific Lab., NM (USA)). Oct 1979. Contract W-7405-ENG-36. 5p. Dep. NTIS, PC A02/MF A01.

Acute oral LD/sub 50/30/ values for mice and rats receiving Irganox 1010 were found to be greater than 5 g/kg. According to classical guidelines, this material would be considered slightly toxic or practically nontoxic in both species. Skin applicaton studies in rabbits showed the material tc be nonirritating. Eye irritation studies, also in the rabbit, showed that Irganox 1010 was a mild but transitory irritant. The sensitizaton study in guinea pigs did not show the material to be deleterious.

3660 (NTIS/PS—79/0230) **Biological effects of oil spills. Volume 1, 1964-1977 (a bibliography with abstracts). Report for 1964-December 1977.** Harrison, E.A. (National Technical Information Service, Springfield, VA (USA)). Mar 1979. 243p. NTIS PC N01/MF N01.

The selected abstracts cover aspects of the biological and ecological effects of oil spills in salt and fresh water. The effects on microorganisms, plants, and animals are studied, along with research on the residues and metabolic products of various oil components. (This updated bibliography contains 237 abstracts, none of which are new entries to the previous edition.)

3661 (NTIS/PS—79/0231) **Biological effects of oil spills. Volume 2, 1978-February, 1979 (a bibliography with abstracts). Report for 1978-February 1979.** Harrison, E.A. (National Technical Information Service, Springfield, VA (USA)). Mar 1979. 60p. NTIS PC N01/MF N01.

The volume of selected abstracts covers aspects of the biological and ecological effects of oil spills in salt and fresh water. The effects on microorganisms, plants, and animals are studied, along with research on the residues and metabolic products of various oil components. (This updated bibliography contains 58 abstracts, all of which are new entries to the previous edition.)

3662 (PNL—2850(Pt.2)(Suppl.)) **Alaskan environmental research. Section 12.0 of Part 2. Ecological Sciences. Pacific Northwest Laboratory annual report for 1978.** Hanson, W.C.; Eberhardt, L.E. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Jul 1979. Contract EY-76-C-06-1830. 31p. Dep. NTIS, PC A03/MF A01.

The objective of this research is to provide an integrated program of investigation for the definition of the ecological consequences of resource developments in northern Alaska. Qualitative and quantitative results are obtained that describe environmental costs incurred by petroleum resource extraction and transportation, including interaction of industrial activities with arctic foxes (Alopex lagopus), small mammals, and tundra-nesting birds in the Prudhoe Bay field and along the Trans-Alaska pipeline and haul road; similar information from the Colville River delta for comparative purposes; baseline information on moose (Alces alces) populations, caribou (Rangifer tarandus) range quality and use, and lichen communities that are or will be impacted by resource developments; field experiments to determine lichen sensitivities to sulfur oxide concentrations likely to be encountered near pipeline pumping stations; food chain transfers of stable and radioactive elements that utilize a data base of some 19 years for comparative purposes; and evaluation of oil field development activities on rabies and other physiological phenomena in foxes. A significant fraction of the research is coordinated through university contracts that utilize academic researchers in specific areas of expertise. During 1978 research continued to emphasize investigations on the ecological consequences of petroleum resource development in northern Alaska. Studies were conducted this year on arctic foxes, tundra-nesting birds, small mammals, caribou, lichens, and fallout radionuclides in the lichen-caribou-Eskimo food web.

3663 **Carcinogenicity of nickel subsulfide for respiratory tract mucosa.** Yarita, T.; Nettesheim, P. (Oak Ridge National Lab., TN). *Cancer Res.;* **38**: 3140-3145(Oct 1978).

The carcinogenicity of nickel subsulfide, Ni_3S_2, for respiratory tract epithelium was studied in heterotopic tracheal transplants with doses of 1 and 3 mg Ni_3S_2 per trachea. Chemical determinations indicated that Ni_3S_2 persisted in the tracheas for seven to nine months. Ni_3S_2 showed marked toxicity for mucociliary epithelium, resulting in widespread atrophy and focal epithelial necrosis during the first two months of exposure. The submucosa showed mononuclear infiltration and signs of fibroblastic and capillary proliferation. Tumor studies indicated that Ni_3S_2 can induce carcinomas in tracheal epithelium. The carcinoma incidence was 10% at 1 mg and approximately 1.5% at 3 mg. The higher dose produced a 67% incidence of fibro- and myosarcomas. The data suggest that, compared to some carcinogenic polycyclic hydrocarbons, Ni_3S_2 may not be a strong carcinogen for the epithelium of conducting airways. The data are discussed in light of other experimental studies and of epidemiological findings on respiratory tract cancers in nickel workers.

3664 **Increases and perturbations in thymocytes forming spontaneous rosettes during viral and chemical oncogenesis in hamsters.** Leffell, M.S. (Univ. of North Carolina, Chapel Hill); Coggin, J.H. Jr. *Clin. Immunol. Immunopathol.;* **11**: vp(1978).

Normal hamster thymocytes were repeatedly observed to form spontaneous (E) rosettes with sheep erythrocytes. The percentage of rosetting thymocytes was subject to reproducible, seasonal variation, fluctuating from consistently high values of up to 17.2% in winter months to < 5% in late summer and fall. The number of rosette-forming cells (RFC) increased during the induction of primary, virally, and chemically induced tumorigenesis irrespective of the seasonal variation. Infection of neonate hamsters with SV40 or adenovirus 31 caused significant increases of 50% or more of RFC cells in the thymuses of individual hamsters assayed as early as 2 weeks after infection. Treatment of weanling hamsters with the carcinogen dimethylbenzanthracene (DMBA) produced significant increases in thymocyte RFC at the time of primary tumor appearance. The increases in RFC induced by carcinogenesis appear to be limited to a particular subset of thymocytes defined by assay in dextran compared to a larger population of RFC which could be determined by assay in the presence of heat-inactivated, SRBC-absorbed serum. Induction of primary tumors had the most effect in increasing RFC within the dextran-defined thymocyte subset, as challenge with tumor cells only effected slight RFC increases.

MAN

REFER ALSO TO CITATION(S) 3651, 3663

3665 (EPA—600/1-78-029) **Reviews of the environmental effects of pollutants: VII. Lead.** Bell, M.A.; Ewing, R.A.; Lutz, G.A.; Holoman, V.L.; Paris, B.; Krause, H.H. (Battelle Columbus Labs., OH (USA)). Oct 1979. 476p. NTIS.

Lead concentrations in the environment have increased significantly since the industrial revolution. Lead contamination reaching the environment is more or less immobilized in insoluble forms. Lead is not biomagnified to any significant extent in man's food chain. The transfer of lead to foods is minimized by its low solubility in environmental media, and by the ability of soil to bind lead ions. The contribution of animal products to human lead burdens is negligible. The most serious toxicological problem at present appears to be lead poisoning in children, primarily as a result of pica and lead-based paints used on old homes. Legislation prompted by community action, mass screening, and improved therapy provide assurance that plumbism attributable to paint sources will continue to decline and possible be eventually eradicated. In recent years, adverse effects of lead have manifested themselves, especially in children, as minor neurological dysfunctions and impairments of motor and mental abilities. Diet is the principal source of lead under normal circumstances; lead from air is a minor contributor. While lead is detectable in all foods, concentrations in food in cans with soldered side seams may exceed twice those in the raw food before canning.

This study reviews the environmental impact of lead. It includes a discussion of the physical and chemical properties, analytical methods, the biological aspects in microorganisms, plants, animals, and humans, environmental distribution and transformation and environmental interactions and their consequences.

3666 (NTIS/PS—79/0228) **Biological effects of lead pollution. Volume 1. 1964-1977 (a bibliography with abstracts). Report for 1964-1977.** Harrison, E.A. (National Technical Information Service, Springfield, VA (USA)). Mar 1979. 233p. NTIS PC N01/MF N01.

The selected abstracts cover the effects of environmental lead contamination on plants, animals, and humans. Included are references which concern the distribution and quantities of lead in various plants and animals. (This updated bibliography contains 227 abstracts, none of which are new entries to the previous edition.)

3667 (NTIS/PS—79/0229) **Biological effects of lead pollution. Volume 2. 1978-February, 1979 (a bibliography with abstracts). Report for 1978-February 1979.** Harrison, E.A. (National Technical Information Service, Springfield, VA (USA)). Mar 1979. 57p. NTIS PC N01/MF N01.

The volume contains selected abstracts covering the effects of environmental lead contamination on plants, animals, and humans. Included are references which concern the distribution and quantities of lead in various plants and animals. (This updated bibliography contains 51 abstracts, all of which are new entries to the previous edition.)

3668 **Hydrogen sulfide poisoning.** Smith, R.P.; Gosselin, R.E. (Dartmouth Medical School, Hanover, NH). *J. Occup. Med.;* **21**: No. 2, 93-97(Feb 1979).

Poisoning by hydrogen sulfide has been recognized as an occupational hazard for at least two centuries. The development of alternative sources of energy in North America may increase the incidence of this medical emergency in the future. Until recently, no specific antidote to sulfide was recognized. We have compared sulfide poisoning to cyanide poisoning and documented recent findings that indicate many similarities between the two. The therapeutic induction of methemoglobinemia, as by the intravenous administration of sodium nitrite, has both protective and antidotal effects against sulfide as well as against cyanide in laboratory animals. This procedure has been used successfully in at least one severe human case of sulfide poisoning. Industries at risk should be prepared to initiate this form of therapy in addition to the usual measures for cardiopulmonary resuscitation. No evidence exists to suggest that sulfide poisoning results in an impairment of the oxygen transport capability of blood. On the other hand, some victims of hydrogen sulfide poisoning exhibit frank cyanosis, suggesting that the respiratory tract obstruction is more common in this condition than is generally recognized. Suction of the upper tract and the administration of oxygen may be important ancillary procedures to the administration of sodium nitrite.

OTHER ENVIRONMENTAL POLLUTANT EFFECTS

REFER ALSO TO CITATION(S) 2960

3669 (DOE/EV—0046(Vol.3), pp 271-288) **Effects of electric fields on small laboratory animals.** Phillips, R.D.; Kaune, W.T. (Battelle Pacific Northwest Labs., Richland, WA). Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

A multidisciplinary research team consisting of physical and biological scientists is conducting a broad and comprehensive study to screen for effects on rodents of acute and chronic exposure to 60 Hz electric fields. Systems were built for the simultaneous exposure of 288 rats and 576 mice to well defined, uniform 60 Hz electric fields free from secondary phenomena such as corona, ozone, shocks and hum. To date, over 600 parameters have been assessed in several thousand rats and mice exposed at 100 kV/m for up to 60 days. No statistically significant, reproducible effects were observed in hematology or serum chemistry parameters, immunological competence, organ and tissue morphology, bone growth and structure, body and organ growth, metabolic status, cardiovascular function, endocrine function, reproductive performance, fertility, fecundity, fetal development or postnatal development. Significant behavioral and neurophysiologic effects have been observed. In short duration behavioral tests (45 minutes), contingently exposed rats spent more time out of the electric field than in it at field strengths $\geq$ 90 kV/m. In longer tests (24 hours, 12-hour light: 12-hour dark), rats contigently exposed at 75 or 100 kV/m spent more time out of the electric field than controls during both the light and dark periods. However, rats contigently exposed at 25 or 50 kV/m spent more time in the field than controls, but only during the 12-hour light period. In the neurophysiologic tests, it was found that fatigue of sympathetic ganglia to repeated stimulation (time to half-amplitude) is slower in rats exposed to 100 kV/m for 30 days than in sham exposed rats.

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 2680

3670 (EPA—600/1-78-047) **Reviews of the environmental effects of pollutants. XII. Hexachlorocyclopentadiene.** Bell, M.A.; Ewing, R.A.; Lutz, G.A. (Battelle Columbus Labs., OH (USA)). Oct 1979. 93p. NTIS.

A review of the scientific literature on the biological and environmental effects of hexachlorocyclopentadiene is presented. Included in the review are a general summary and a comprehensive discussion of the following topics as related to hexachlorocyclopentadiene and specific hexachlorocyclopentadiene compounds: physical and chemical properties; occurrence; synthesis and use; analytical methodology; biological aspects in microorganisms, plants, wild and domestic animals, and humans; distribution mobility, and persistence in the environment; and an assessment of present and potential health and environmental hazards. More than 100 references are cited. The document also contains an evaluation of potential hazard resulting from hexachlorocyclopentadiene contamination in the environment and suggests current research needs.

3671 (ORNL—5037) **Nuclear war survival skills.** Kearney, C.H. (Oak Ridge National Lab., TN (USA)). Sep 1979. Contract W-7405-ENG-26. 259p. Dep. NTIS, PC A12/MF A01.

This book includes chapters on psychological preparations, warning and communications, and evacuation. It describes the building of expedient shelters, their ventilation and cooling, the purification and storage of adequate water, the processing and cooking of whole grains and legumes, fallout meters, protection against fires and carbon monoxide, and expedient furnishings for shelters. Other chapters cover sanitation and preventive medicine, medical advice for nuclear survivors lacking the help of doctors, improvised footwear and clothing, and advice on minimum preparations that can be made at low cost and should be made before a crisis arises. One appendix of the handbook gives detailed, field-tested instructions for building six types of earth-covered expedient fallout shelters, with criteria to guide the choice of which shelter to build. Others contain instructions for making an efficient shelter-ventilating pump and a homemade fallout meter that is accurate and dependable with inexpensive materials found in most households. This report is primarily a compilation and summary of civil defense measures and inventions developed at ORNL over the past 14 years and field-tested in six states, from Florida to Utah. It is the first comprehensive handbook of survival information for use by untrained citizens who want to improve their chances of surviving a possible nuclear attack. Sections may be easily excerpted and reproduced for mass distribution through news media. (PCS)

GEOSCIENCES

REFER ALSO TO CITATION(S) 2898

GEOLOGY AND HYDROLOGY

REFER ALSO TO CITATION(S) 2643, 2671

3672 **Wyoming mineral industry: a summary by the staff of the Geological Survey of Wyoming.** Laramie, WY; Geological Survey of Wyoming (1978). 32p. (NP—24079). $1.00.

Wyoming has a variety of rock types at or near the surface containing minerals and fluids useful to man. These resources will provide substantial business, employment, and income to the state and its people for a long time. Some of these resources, such as petroleum, natural gas, coal, uranium, bentonite, and trona are being developed at present and have established national and international markets. Daniel N. Miller, Jr., focuses on minerals in Wyoming in a paper, "Wyoming's Mineral Legacy - a Geological Perspective." In a paper, "Oil and Gas Remain Dominant Forces in Minerals Industry," Alan J. Ver Ploeg discusses historical background, geologic setting, drilling and production, exploration and reserves, refining and transportation, and forecasts of oil and gas and oil shales as the resource of the future. Gary B. Glass discusses coal in a paper, "Coal - the Rebirth of an Industry." Many other mineral resources in Wyoming are discussed in "Wyoming's Economic Prospects Brightened by Mineral Diversity," W. Dan Hausel, that include trona,

uranium, iron, bentonite, and some smaller deposits of feldspar, phosphate, gypsum, jade, vermiculite. Potential industries include diamonds, copper, gold, potash, pumice, zeolite, and anorthosite. (MCW)

GEOPHYSICS

SEISMOLOGY AND TECTONICS

3673 (UCID—18191) **Remote system software.** Gong, T.H. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 17 May 1979. Contract W-7405-ENG-48. 27p. Dep. NTIS PCE03/MF E03.

This document is a collection of notes and software documentation describing the Lawrence Livermore Laboratory Digital Seismic System (DS^2). The system consists of four remote stations in California, Nevada, and Utah that transmit seismic data to the Livermore central computer. 3 figures.

3674 **Seismic wave attenuation in rocks.** Mavko, G.; Kjartansson, E.; Winkler, K. (Rock Physics Project, Department of Geophysics, Stanford University, Stanford, CA 94305). EY76-5-03-0326 PA 45. *Rev. Geophys. Space Phys.;* **17**: No. 6, 1155-1164(Sep 1979).

Recent results in seismic wave energy losses are reviewed. Among the topics disscussed are frequency dependence, viscous flow, Q models, thermoelasticity, and dislocation kinks.(AIP)

MINERALOGY, PETROLOGY, AND ROCK MECHANICS

REFER ALSO TO CITATION(S) 2630, 2637

3675 (METC/SP—79/3) **Application of fractography to core and outcrop fracture investigations.** Kulander, B.R.; Barton, C.C.; Dean, S.L. (Department of Energy, Morgantown, WV (USA). Morgantown Energy Research Center). Mar 1979. 184p. Dep. NTIS, PC A09/MF A01.

Purpose of this paper is to introduce geologists to the principles of fractography, especially those principles that govern the formation of fracture surface structures commonly observed in rocks. A knowledge of the inception mechanics governing the formation of a fracture's tendential and transient structures should provide geologists with a method to distinguish natural from coring-induced and handling-induced fractures in oriented core samples, and show how coring-induced fractures may be assisted in their formation by stresses that can be attributed to the drilling process. 118 figures.

3676 (RHO-SA—93) **Columbia River Basalt reference sample.** Additon, M.K.; Seil, R.O. (Rockwell International Corp., Richland, WA (USA). Rockwell Hanford Operations). Apr 1979. Contract EY-77-C-06-1030. 32p. (CONF-7904116—1). Dep. NTIS, PC A03/MF A01.

From Geological Society of America cordilleran section meeting; San Jose, CA, USA (10 Apr 1979).

A Columbia River Basalt reference sample, ARHCO-1, has been prepared for use as a standard in basalt research projects. Approximately 112 kg of basalt was collected from the Umatilla flow of the Columbia River Basalt Group at Finley Quarry, Washington (46°07'N, 119°02'W). The basalt sample was powdered, split, and randomly ordered. Analyses of major and minor oxides and trace elements were performed. Analysis of variance of the data shows that with few exceptions the sample is homogeneous at $F_{0.95}$.

3677 (SAND—79-0114) **Indirect deformation (strain) measurements and calibrations in Sandia triaxial apparatus for rock testing to 250°C.** Wawersik, W.R. (Sandia Labs., Albuquerque, NM (USA)). Sep 1979. Contract EY-76-C-04-0789. 53p. Dep. NTIS, PC A04/MF A01.

Indirect procedures for axial and radial strain measurements on rock in triaxial tests to 250°C are presented. The description of techniques includes discussions of all calibrations and of the accuracies of measurements. In addition, two examples are given to show how the techniques are implemented in triaxial compression and triaxial extension experiments. 10 figures.

3678 **Plane shock wave studies of porous geologic media.** Larson, D.B.; Anderson, G.D. (University of California, Lawrence Livermore Laboratory, Livermore, California 94550). *J. Geophys. Res.;* **84**: No. B9, 4592-4600(10 Aug 1979).

Plane shock wave experiments have been conducted on two highly porous rocks, Mount Helen tuff and Indiana limestone, in both dry and water-saturated states up to stress levels of about 4 GPa. A light-gas gun was used to load the sample in uniaxial strain, and subsequent wave motion was monitored with particle-velocity gages. All four materials studied show evidence of time-dependent behavior. The time-dependent behavior in the highly porous dry rocks is associated with the closing of pores. The strong time dependence observed in these materials would seem to preclude the use of quasi-static data in constitutive models that are used to describe dynamic processes. In the water-saturated rocks the time dependence is associated with the water, which shows no indication of transformation to the high-pressure ice phases in the time frame of these shock wave experiments. This suggests the possibility of a metastable form of water existing under dynamic conditions.

3679 **Electrical conductivity of pyroxene which contains trivalent cations: Laboratory measurements and the lunar temperature profile.** Huebner, J.S.; Duba, A.; Wiggins, L.B. (U. S. Geological Survey, Reston, Virginia 22092). *J. Geophys. Res.;* **84**: No. B9, 4652-4656(10 Aug 1979).

Three natural orthopyroxene single crystals, measured in the laboratory over the temperature range 850°—1200°C, are more than 1/2 order of magnitude more electrically conducting than previously measured crystals. Small concentrations (1—2%) of Al_2O_3 and Cr_2O_3 present in these crystals may be responsible for their relatively high conductivity. Such pyroxenes, which contain trivalent elements, are more representative of pyroxenes expected to be present in the lunar mantle than those which have been measured by other investigators. The new conductivity values for pyroxene are responsible for a relatively large bulk conductivity calculated for (polymineralic) lunar mantle assemblages. The results permit a somewhat cooler lunar temperature profile than previously proposed. Such lower profiles, several hundred degrees Celsius below the solidus, are quite consistent with low seismic attenuation and deep moonquakes observed in the lunar mantle.

GEOCHEMISTRY

REFER ALSO TO CITATION(S) 2540

3680 **Theoretical estimate of compressional changes of decay constant of ^{40}K.** Bukowinski, M.S.T. (Department of Geology and Geophysics and Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *Geophys. Res. Lett.;* **6**: No. 9, 697-699(Sep 1979).

A theoretical calculation of the charge density in metallic K is used to estimate pressure induced changes in the electron-capture decay constant λ/sub e/, of ^{40}K. It is predicted that λ/sub e/ goes through a maximum at approximately 3.5-fold compression and approaches its one atmosphere value at pressures corresponding to those in the outer-core of the earth. The maximum predicted change of about 4×10^4 years in the halflife is negligible when compared to the current experimental uncertainties, which are of the order of 10^7 years.

OCEANOGRAPHY

3681 **Barotropic and Baroclinic tides over the continental slope and shelf off Oregon.** Torgrimson, G.M.; Hickey, B.M. (Department of Oceanography, University of Washington, Seattle 98195). *J. Phys. Oceanogr.;* **9**: No. 5, 945-961(Sep 1979).

During the Coastal Upwelling Experiment of 1973, several current meter moorings were deployed on the Oregon continental shelf and slope. Data from 16 current meters and temperature sensors which were deployed a long a line perpendicular to the bathymetric contours were analyzed by the response method of tidal analysis (Cartwright et al., 1969). The diurnal tidal current was predominantly barotropic over the slope and shelf. The semi-diurnal current was strongly baroclinic. Semi-diurnal characteristics were computed from the model of Mooers (1970, 1975a) using STD data taken during the period of mooring deployment. The computed semi-diurnal characterics, combined with the distribution of signal-to-noise ratios and the phase of the horizontal and vertical velocities, are consistent with generation of the internal tide as a wide beam (~80 m) along the continental slope between 474 and 1050 m. The beam reflects from the sea surface and from the sea floor over the shelf as it passes through the mooring sites. The beam is present at least 50 km from the generation area. Barotropic and baroclinic components of the current were separated at each sensor. It was shown that the baroclinic components satisfy the momentum balance for internal waves. Baroclinic currents were as large or slightly larger than barotropic currents, which is consistent with available models. Baroclinic dissipation rates in mide-shelf and inner shelf regions (1.5×10^{-5} Wm^{-3}) are comparable to those found by Wang and Mooers (1977) for the same data set but using different methods of analysis. Baroclinic energy was dissipated more strongly on the outer shelf (2.5×10^{-5} Wm^{-3}).

PHYSICS RESEARCH

ASTROPHYSICS AND COSMOLOGY

COSMIC RADIATION

3682 (LBL—9699) **Superconducting magnet system for the SPIRIT cosmic ray space telescope.** Green, M.A.; DeOlivares, J.M.; Tarle, G.; Price, P.B.; Shirk, E.K. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Aug 1979. Contract W-7405-ENG-48. 19p. (CONF-790815—32). Dep. NTIS, PC A02/MF A01.

From Cryogenic engineering conference; Madison, WI, USA (21 Aug 1979).

The SPIRIT (A Superconducting Passive Iron Isotope Telescope) experiment requires a large volume ($1m^3$) of 2T field in order to achieve enough resolution to study heavy primary cosmic rays. It is proposed that the SPIRIT superconducting magnet system and its experimental package would be used in one of the space shuttles. The superconducting magnet design is based on Lawrence Berkeley Laboratory thin high current density solenoid technology. The superconducting magnet system consists of a number of coils which generate a 2T induction within the experiment, and at the same time allow free access to the package by cosmic rays. The superconducting magnet system uses high current density conductor which is protected by a shorted secondary circuit. The magnet coils are to be cooled by pumped two phase helium which is circulated through tubes. Refrigeration is supplied from a large liquid helium dewar.

3683 **Explosive quark matter and the "Centauro" event.** Bjorken, J.D.; McLerran, L.D. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). *Phys. Rev., D;* **20**: No. 9, 2353-2360(1 Nov 1979).

We study the hypothesis that the "Centauro" event found by the Brazil-Japan cosmic-ray emulsion collaboration is initiated by the explosion of a metastable glob of highly compressed hadronic matter present in the primary spectrum. A crude liquid-drop model is formulated to investigate the properties of the equation of state necessary to support such a hypothesis. The evolution of such a glob as it moves through the atmosphere and eventually explodes is described. Two other variants are also discussed: one is that the glob contains an unconfined, massive quark, while the other is that the lowest-mass fractionally charged hadron has large baryon number. In that case, the Centauro event consists of fragmentation of a nucleon primary into such objects. The most prominent experimental consequences of our speculations appear to be the existence of peculiar explosive events at high altitudes at a rate $<$ or $\approx 10^3\ m^{-2}\ yr^{-1}$, and/or penetrating particles of high ionization density at sea level containing fractional charge.

STARS

3684 **Interacting supernova remnants: Tunnels in the sky.** Jones, E.M.; Smith, B.W.; Straka, W.C.; Kodis, J.W.; Guitar, H. (University of California, Los Alamos Scientific Laboratory). *Astrophys. J.;* **232**: No. 1, 129-138(15 Aug 1979).

Two-dimensional calculations of near-surface, atmospheric nuclear fireballs and interacting supernova remnants (SNRs) are presented. The fireball calculations demonstrate the ability of the LASL program YAQUI to reproduce known time-dependent evolution of fireballs. The SNR calculation describes the interaction of two remnants aged 6400 and 32000 years. A dense plug is formed which separates the two cavity volumes. The combined volume of the cavities is 80% of the sum of the volumes of two isolated remnants but exceeds the union volume of two overlapping, noninteracting remnants. The resultant tunnel fraction is then greater than the value derived from simple considerations.

3685 **Pulsation modal behavior of classical Cepheids in the HR diagram.** Cox, A.N.; Hodson, S.W. (Los Alamos Scientific Lab., NM). pp 237-240 of HR diagram. Philip. A.G.D.; Hayes, D.S. (eds.). Sauverney, Switzerland; International Astronomical Union (1978).

Mapping of the Cepheid region of the Hertzsprung-Russell diagram has been difficult to do from a theoretical viewpoint because the masses and compositions of the Cepheids have always been very uncertain. It now appears that the various mass anomalies have been solved by distance scale changes and by the realization of very helium rich convection zones. This helium enrichment is caused by a Cepheid wind which blows away more hydrogen than helium, just as in the solar wind. Now with the evolutionary theory masses, radii, luminosities, and the new composition structures, the predicted blue edges of the instability strip and periods throughout the strip agree very well with observations.

SOLAR PHENOMENA

3686 **Stability of the ordinary mode to an electron heat flux.** Lemons, D.S.; Feldman, W.C.; Gary, S.P. (Los Alamos Scientific Lab., NM (USA)). *Sol. Phys.;* **59**: No. 2, 387-393(Oct 1978).

Stability equations for the low frequency ordinary mode propagating perpendicular to a homogeneous magnetic field in the presence of a heat flux in a collisionless plasma are derived by working within an appropriate velocity reference frame. Solutions indicate the ordinary mode is stable under average solar wind conditions at 1 AU.

COSMOLOGY

3687 **Number of neutrino species and the lepton number of the universe.** Dimopoulos, S.; Feinberg, G. (Physics Department, Columbia University, New York, New York 10027). *Phys. Rev., D;* **20**: No. 6, 1283-1289(15 Sep 1979).

If the universe has an excess of electron neutrinos comparable to the number of photons, then the cosmological helium abundance does not restrict the number of neutrino types significantly. We discuss lepton-number-violating processes, both in grand unified theories, and arising from black-hole production and decay in the early universe.

PLANETARY PHENOMENA

3688 **Trace element evidence for a laterally inhomogeneous moon.** Jovanovic, S.; Reed, G.W. Jr. (Argonne National Lab., IL). *Geochim. Cosmochim. Acta, Suppl.;* 59-80(1978).

A number of trace element interrelations support the concept of a laterally inhomogeneous moon based orginally in Cl/sub r// P_2O_5 ratios. The correspondence between Cl/sub r// P_2O_5 and Rb/Sr ratios in basalts are of special interest since the isotopic evolution of the latter pair of elements relates to the earliest history of the moon. This implies the times when the Cl/sub r// P_2O_5 relations were established. The early magma ocean is conjectured to have been made up of nonintermixing seas resulting either from large convection cells or large body accretion. These mutually exclusive regions could be lunar geological provinces. It is proposed that the diversity of basalts from the Apollo 17 site is related to the lateral inhomogeneity of the moon. Ca/Na ratios in basalts show a trend which parallels that of Ru/Os and in a corresponding fashion may serve as a depth indicator. 4 figures, 4 tables, 12 references.

ATMOSPHERIC PHYSICS

3689 (ANL—78-65(Pt.1), pp 114-118) **Possible role of resonant dissociation processes as a source of atmospheric heating in the thermosphere.** Spence, D.; Burrow, P.D. 1978.

In Radiological and Environmental Research Division annual report: fundamental molecular physics and chemistry, October 1977-September 1978.

A speculative discussion of the mechanisms for atmospheric heating in the thermosphere is given. The product of known cross sections for N atom production and the measured electron flux are examined. A plot of this cross section times the electron flux as a function of electron energy typical of conditions in the thermosphere is shown. Three regions are indicated corresponding to resonant dissociation, electron dissociation, and dissociation ionization. 21 references. (JFP)

3690 (LA—7954-MS) **Preliminary considerations concerning neutral plasma beam propagation across a magnetic field.** Shanahan, W.R.; Faehl, R.J.; Godfrey, B.B. (Los Alamos Scientific Lab., NM (USA)). Aug 1979. Contract W-7405-ENG-36. 42p. Dep. NTIS, PC A03/MF A01.

A plan to address physical questions of interest for exoatmospheric military applications of intense neutralized plasma beams is described. After a brief review of earlier work relevant to this matter and a detailed explanation of why such work cannot answer questions of present interest, a plan employing interactive application of several numerical and analytic techniques to treat relevant phenomena occurring on the various rather disparate time and length scales involved is suggested. The first part of the study would determine the macroscopic features of beam propagation through calculations effected with a magnetohydrodynamical numerical code. Classical transport coefficients would be employed in this initial phase. Using information thus gained concerning gross charge and current distributions, particle-in-cell simulations would be initialized to study those microscopic, phase-space-dependent phenomena which can alter the phenomonological transport coefficients appearing in the fluid description. Insight thereby gained concerning anomaous, collectively induced transport effects would then be applied to yield a refined, accurate description of the macroscopic aspects of neutral plasma beam propagation. Personnel and computational resources available at the Los Alamos Scientific Laboratory are described.

Results of a very preliminary particle-in-cell simulation of a neutral plasma beam propagating across a magnetic field are presented.

AURORAL AND IONOSPHERIC PHENOMENA

3691 (LA—8048-MS(Vol.1)) **Aguila pre-operations plan.** Simons, D.; Pongratz, M.; Duran, M.; Barasch, G. (Los Alamos Scientific Lab., NM (USA)). Sep 1979. Contract W-7405-ENG-36. 32p. Dep. NTIS, PC A02/MF A01.

Aguila, a small-rocket experiment addressing the structuring of ionospheric plasmas, is described. A Terrier-Malemute two-stage rocket will be launched approximately north from Kauai Test Facility after sunset between October 8 and October 21, 1979, universal time. Aguila will deposit three barium clouds: before apogee at about 360 and 520 km, and just after apogee at 560 km. These clouds will be photoionized by the sun and observed using intensified-camera and television systems and photometers that are sensitive to barium line radiations. These observations will be made from ground stations on Mt. Haleakala, Maui, and at the launch site. Each cloud's striation time and subsequent behavior will elucidate mechanisms believed to drive ionospheric-plasma morphology.

MAGNETOSPHERIC PHENOMENA

3692 (ATR—79(7824)-2) **Argon-ion contamination of the plasmasphere.** Chiu, Y.T.; Cornwall, J.M.; Luhmann, J.G.; Schulz, M. (Aerospace Corp., El Segundo, CA (USA)). 15 Jul 1979. Contract W-7405-ENG-48. 48p. Dep. NTIS, PC A03/MF A01.

This paper applies present observational and analytic knowledge on effects of plasma beam interaction wth the magnetosphere to the plasmasphere contamination problem of the argon ion engine exhaust expected to be deposited in the magnetosphere during the construction phase of the Satellite Power System. Effects of plasmasphere, ionosphere, and radiation belt modifications are discussed.

ATOMIC, MOLECULAR, AND CHEMICAL PHYSICS

REFER ALSO TO CITATION(S) 3313, 3455, 3655

3693 (ANL—78-65(Pt.1)) **Radiological and Environmental Research Division annual report: fundamental molecular physics and chemistry, October 1977-September 1978.** (Argonne National Lab., IL (USA)). 1978. Contract W-31-109-ENG-38. 196p. Dep. NTIS, PC A09/MF A01.

Research presented includes 32 papers, six of which have appeared previously in ERA, and 26 appear in this issue of ERA. Molecular physics and chemistry including photoionization, molecular properties, oscillator strengths, scattering, shape resonances, and photoelectrons are covered. A list of publications is included. (JFP)

3694 Observations of the electric quadrupole moments of a number of nuclear levels: ^{111}Cd (247 keV), ^{115}In (ground state), ^{119}Sn (24 keV), and ^{121}Sb (ground state) : based on the electric field gradients in a series of trans-[dimethyl organometallic moieties]. Sham, T.K. (Chemistry Department, Brookhaven National Laboratory, Upton, New York 11973). *J. Chem. Phys.;* **71**: No. 9, 3744-3749(1 Nov 1979).

Nuclear electric quadrupole moments (Q) found in the literature for the 247 keV level of ^{111}Cd, the ground state of ^{115}In, the 24 keV level of ^{119}Sn, and the ground state of ^{121}Sb are used to calculate values for electric field gradients (eq/sup n/) at the nuclear sites in a series of isoelectronic, pseudoisostructural, linear $(CH_3)_2M$ moieties (M=Cd/sup II/, In/sup III/, Sn/sup IV/, and Sb/sup V/) whose nuclear quadrupole coupling constants (e^2q/sup n/Q) have been reported previously. Because several widely different Q values exist for each of these levels, the range of eq/sup n/ permitted is large and opposing conclusions about the bonding of a given system cannot be excluded. Q (^{119}Sn) =-0.065b is used as a reference to compare electric field gradients based on all these Q values.

3695 Improved ab initio effective core potentials for molecular calculations. Christiansen, P.A.; Lee, Y.S.; Pitzer, K.S. (Department of Chemistry and Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *J. Chem. Phys.;* **71**: No. 11, 4445-4450(1 Dec 1979).

We have investigated the sources of error in bond lengths and dissociation energies computed from ab initio effective potentials derived from Phillips—Kleinman type pseudo-orbitals. We propose an alternate pseudo-orbital, effective potential treatment with the primary objective of agreement with all-electron molecular calculations. This new treatment forces the pseudo-orbitals to match precisely the Hartree—Fock orbitals in the valence region and thereby eliminates the major cause of error in the earlier calculations. Effective core potentials derived from these revised pseudo-orbitals were used to compute potential energy curves for the ground states of F_2, Cl_2, and LiCl and the results are compared with previous all-electron and effective potential calculations. Our effective potentials yield dissociation energies and bond lengths which are in excellent agreement with the all-electron values. Furthermore, in contrast to other procedures, our revised effective potentials result in an excellent description of the inner repulsive walls of the dissociation curves.

3696 Combined multiple pulse NMR and sample spinning: Recovery of ^{1}H chemical shift tensors. Taylor, R.E.; Pembleton, R.G.; Ryan, L.M.; Gerstein, B.C. (Ames Laboratory, U. S. Department of Energy, and Department of Chemistry, Iowa State University, Ames, Iowa 50011). *J. Chem. Phys.;* **71**: No. 11, 4541-4545(1 Dec 1979).

Combined multiple pulse NMR and sample spinning techniques have been used to obtain the carboxylic acid ^{1}H chemical shift tensor in 2,6-dimethylbenzoic acid. The values obtained were σ/sub perpendicular/=-18.5 ppm and σ/sub parallel/=-4.2 ppm relative to TMS. A discussion of the changes in line shape of chemical shift tensors under sample rotation is given. This leads to a quantitative expression for the sample rotation speed, ω/sub r/ >>σ/sub z/z-1/3Trσ, to define "rapid" sample rotation.

3697 Isotope chemistry and molecular structure. The WINIMAX weighting factor. Lee, M.W.; Bigeleisen, J. (Savannah River Laboratory, E. I. du Pont de Nemours Co., Aiken, South Carolina 29801). *J. Chem. Phys.;* **71**: No. 11, 4661-4663(1 Dec 1979).

The modulating coefficients for the finite polynomial expansion of the logarithm of the reduced partition function, lnb (u), of a harmonic oscillator have been obtained for the range of 0< or =u< or =u/sub max/ with a weighting function g (u) =u/sup a/ by the method of least squares. The coefficients obtained for a=o are almost identical with the MINIMAX coefficients which correspond to an unweighted expansion; the least square coefficients obtained with a=1 are almost identical with the finite orthogonal polynomial coefficients derived by Ishida, Spindel, and Bigeleisen with the assumption g (u) ~u. Comparison of the least square modulating coefficients derived as a function of u shows that the WINIMAX coefficients for the reduced vibrational partition function derived by Lee and Bigeleisen corresponds to a weighting function u^6. It is shown that this weighting function is near optimum to insure minimum amplitudes of oscillation in the expansion of lnb (u) as a function of the order of the expansion and to include most of the important molecular structure information contained in the moments of the eigenvalues. Beyond Σu/sub i/^{6}, there is little new structural information.

BEAMS AND THEIR REACTIONS

REFER ALSO TO CITATION(S) 3690, 3728, 3852, 3881

3698 (ANL—78-65(Pt.1), pp 43-50) **Electrostatic lens calculation.** Dillon, M.A. 1978.

In Radiological and Environmental Research Division annual report: fundamental molecular physics and chemistry, October 1977-September 1978.

A lens program is described in which previous parameterizations appear as a block of subroutines. As an example, the code is used to optimize the performance of an electrostatic lens designed previously to implement the analysis of electron scattering studies. 1 reference. (JFP)

3699 (ANL—78-65(Pt.1), pp 125-127) **Note on a possible source of error in electron impact ionization cross section measurements by parallel plate condensers.** Spence, D. 1978.

In Radiological and Environmental Research Division annual report: fundamental molecular physics and chemistry, October 1977-September 1978.

A possible source of error, never seen discussed previously in electron impact ionization cross section measurements by parallel plate condensers, is pointed out and concerns the ejection of secondary electrons from the condenser plates by the impact of positive ions. The effect of this phenomenon on the apparent positive ion current is described. 8 references. (JFP)

3700 (LBL—9482) **Determination of morphology and electronic structure in solids with 20-1000 eV radiation.** Denley, D.R. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.; California Univ., Berkeley (USA). Dept. of Physics). Aug 1979. Contract W-7405-ENG-48. 174p. Dep. NTIS, PC A08/MF A01.

Thesis.

One of the most versatile probes for spectroscopy is the photon because it is readily tuned through a wide range of frequencies, it is chargeless, and because of the additional information available from its vector nature. With the advent of intense radiation light sources a nearly untouched region of the spectrum has become available for a wide range of new experiments. Two of the main techniques in use are those of absorption and photoemission. This thesis uses these techniques on a variety of different materials for the analysis of their morphology and electronic structure. The principles

underlying the techniques of soft-x-ray absorption, bulk-, and surface-photoemission are discussed together with some of the experimental methods and instrumentation.

3701 Intense pulsed magnetically insulated deuteron source. Endo, G.; Robertson, S. (Physics Department, University of California, Irvine, California 92717). *Appl. Phys. Lett.;* **35**: No. 11, 849-850(1 Dec 1979).

We have constructed a magnetically insulated ion source in which deuterons are extracted from plasma generated by a deuterated titanium washer located within the field excluding anode. Peak beam parameters are 0.8 A/cm^2 at 140 kV for 0.4 μsec with a 14-mm anode-cathode gap. Faraday cup measurements show significantly fewer impurities in the deuteron beam than in proton beams extracted from surface flashover plasma.

ATOMIC AND MOLECULAR PROPERTIES

REFER ALSO TO CITATION(S) 3741, 3784, 3785

3702 (ANL—78-65(Pt.1), pp 4-9) **Photoionization of H_2O at high resolution.** Dehmer, P.M.; Chupka, W.A. 1978.

In Radiological and Environmental Research Division annual report: fundamental molecular physics and chemistry, October 1977-September 1978.

The relative photoionization cross sections for the formation of H_2O^+, OH^+, and H^+ from H_2O were measured at high wavelength resolution using a 3-meter photoionization mass spectrometer equipped with a quadrupole mass filter and a 1-meter photoionization mass spectrometer equipped with a 12-inch radius, 60° sector magnetic mass spectrometer. Discrete structure in the parent ion photoionization efficiency curve is interpreted in terms of Rydberg series converging to excited states of the H_2O^+ ion. 9 references.

3703 (ANL—78-65(Pt.1), pp 10-12) **Photoionization of CO.** Dehmer, P.M.; Chupka, W.A. 1978.

In Radiological and Environmental Research Division annual report: fundamental molecular physics and chemistry, October 1977-September 1978.

The relative photoionization cross section for CO taken at liquid nitrogen temperature and a wavelength resolution of 0.07 A (FWHM) is presented in the wavelength region between the ionization threshold at 884.73 A and 600 A.

3704 (ANL—78-65(Pt.1), pp 13-18) **Photoionization of the hydrogen halides-Rydberg series converging to the $A^2\Sigma^+$ state of the HX^+ ion (X=Cl, Br, I).** Dehmer, P.M.; Chupka, W.A. 1978.

In Radiological and Environmental Research Division annual report: fundamental molecular physics and chemistry, October 1977-September 1978.

Relative photoionization cross sections were determined for HCl, HBr, and HI at high wavelength resolution using a cooled ionization chamber. Spectra are presented in the wavelength region from the ionization threshold to approximately the convergence limit of the $HX^+ A^2\Sigma^+$ state for each molecule. Rydberg state structure converging to the A state of the HX^+ ions is shown. 6 references.

3705 (ANL—78-65(Pt.1), pp 19-21) **Photoionization of Xe, HI, and CH_3-I-analogies between atomic and molecular Rydberg states.** Dehmer, P.M.; Chupka, W.A. 1978.

In Radiological and Environmental Research Division annual report: fundamental molecular physics and chemistry, October 1977-September 1978.

Relative photoionization cross sections are presented for Xe, HI, and CH_3I in the wavelength region between the ^{2}P/sub 3/2/ and ^{2}P/sub 1/2/ limits in Xe^+, the ^{2}II/sub 3/2/ and ^{2}II/sub 1/2/ limits in HI^+, and the ^{2}E/sub 3/2/ and ^{2}E/sub 1/2/ limits in CH_3I^+. The analogies between the rare gas spectrum and the molecular spectra are discussed. 4 references.

3706 (ANL—78-65(Pt.1), pp 22-27) **Photoelectron spectroscopy of the $^2B_3$/sub u/ + e^- reverse arrow ^1A/sub g/ transition in ethylene.** Dehmer, P.M.; Dehmer, J.L. 1978.

In Radiological and Environmental Research Division annual report: fundamental molecular physics and chemistry, October 1977-September 1978.

The He I 584 A photoelectron spectrum of C_2H_4 $^+{}^2B_3$/sub u/ + e^- C_2H_4 ^1A/sub g/ transition in ethylene is taken at a spectrometer resolution of 23 MeV using a supersonic molecular beam source to cool the target gas. Greater detail is shown that in previous measurements the results are related to an interpretation of the vibrational structure in the 3s Rydberg state. 17 references. (JFP)

3707 (ANL—78-65(Pt.1), pp 28-29) **Photoelectron spectrum of N_2O.** Dehmer, P.M.; Dehmer, J.L. 1978.

In Radiological and Environmental Research Division annual report: fundamental molecular physics and chemistry, October 1977-September 1978.

The HeI 584 A photoelectron spectrum of N_2O was determined at a spectrometer resolution of 16 MeV using both effusive and supersonic molecular beam sources. New structure is observed in all of the electronic bands studied. A preliminary report is given. 2 references.

3708 (ANL—78-65(Pt.1), pp 30-35) **Oscillator-strength distributions for methanol and ethanol from 7.5 to 11.8 eV.** Person, J.C.; Nicole, P.P. 1978.

In Radiological and Environmental Research Division annual report: fundamental molecular physics and chemistry, October 1977-September 1978.

A new absorption cell and split-beam detector system with photomultipliers and photon-counting equipment has been installed. The data analysis is described, and new determinations of the oscillator strength are presented for methanol from 7.66 to 11.76 eV and for ethanol from 7.52 to 11.76 eV. 8 references.

3709 (ANL—78-65(Pt.1), pp 38-41) **Atomic photoionization calculations using local continuum exchange approximations.** Siegel, J.; Dehmer, J.L.; Dill, D. 1978.

In Radiological and Environmental Research Division annual report: fundamental molecular physics and chemistry, October 1977-September 1978.

Results using some previous models for atomic photoionization were calculated using all four forms of the dipole operator: length, velocity, acceleration based on the initial-state potential gradient, and acceleration based on the final-state potential gradient. Calculations were performed on one or more subshells of six atoms. In no case did a previous result agree better with the corresponding Hartree-Fock result than did the Hartree-Slater calculation. The four operators results within each subshell are compared in order to understand this. It is concluded that open-shell interactions must be taken into account in model exchange potentials for photoionization. An untested implication is that the success with electron - molecule scattering calculations is due to the restriction to electron closed-shell cases. 12 references. (JFP)

3710 (ANL—78-65(Pt.1), pp 59-61) **Photoionization of the nitrogen K-shell in HCN.** Dehmer, J.L.; Siegel, J.; Dill, D. 1978.

In Radiological and Environmental Research Division annual report: fundamental molecular physics and chemistry, October 1977-September 1978.

Preliminary calculations of the photoionization cross section for the nitrogen K-shell in HCN are reported. The one-electron features resemble those of the isoelectronic molecule N_2. 10 references.

3711 (ANL—78-65(Pt.1), pp 68-76) **Fixed-molecule photoelectron angular distributions: fixed-atom (isotropic) limit.** Dill, D.; Wallace, S.; Dehmer, J.L. 1978.

In Radiological and Environmental Research Division annual report: fundamental molecular physics and chemistry, October 1977-September 1978.

Ejection of photoelectrons along the electric vector of the light from an orbital $n_0l_0m_0$ in an atomic (isotropic) environment yields the angular distribution vertical bar Yl_0m_0 vertical bar^2. This result, pointed out by Fadley, is obtained in the general formalism of fixed-molecule angular distribution (FMAD) developed recently. The dynamical requirements for the result and its generalization to photoelectron detection at arbitrary (fixed) angle relative to the electric vector are given. The intensity of the angular distribution reflects interference between the alternative orbital momenta of the ejected electron and should be, therefore, a sensitive function of light frequency near threshold, where effects of the Coulomb field are strong, and across photoionization resonances. The analysis may be relevant to, e.g., photoionization of orbitals protruding from transition-metal surfaces. 15 references.

3712 (ANL—78-65(Pt.1), pp 128-132) **Differential trapped electron spectroscopy: a novel technique for obtaining Franck-Condon factors and identifying threshold structures.** Spence, D. 1978.

In Radiological and Environmental Research Division annual report: fundamental molecular physics and chemistry, October 1977-September 1978.

A simple novel technique for extracting accurate Franck-Condon factors from threshold electron spectra is introduced in which the instrumental resolution is insufficient to completely resolve vibrational energy levels. An interesting extension of the technique is its ability to identify those energy levels which have sharp maxima at threshold for excitation by electron impact, without the effort of actually measuring such a cross section. These threshold peaks are usually caused by closely neighboring negative ion resonances. These two properties of the technique are described in more detail. 8 references.

3713 (ANL—78-65(Pt.1), pp 133-136) **Electron impact excitation cross sections of the n = 2 states of helium by electron impact.** Spence, D.; Stuit, D. 1978.

In Radiological and Environmental Research Division annual report: fundamental molecular physics and chemistry, October 1977-September 1978.

The electron impact excitation of the He 2^3S, ^1S, ^3P cross sections were reinvestigated from threshold to a maximum of 8 eV above threshold (in the case of the ^3S state). Data are plotted showing a comparison of theoretical and experimental values of the He $1s2S^3S$ and $1s2s^1S$ excitation cross sections. 6 references. (JFP)

3714 (ANL—78-65(Pt.1), pp 137-144) **Measurements of the ratio of the He $2^1s/2^3s$ energy integrated total cross sections from threshold to 0.12 eV comparison with theory.** Spence, D. 1978.

In Radiological and Environmental Research Division annual report: fundamental molecular physics and chemistry, October 1977-September 1978.

The trapped electron method is used to measure the ratio of the helium $2^1S/2^3S$ energy integrated total (with respect to angle) cross sections from threshold to 0.12 eV above threshold. It is pointed out that it is incorrect to say that cross section ratios are resolution dependent in this energy region. It is demonstrated that such ratios are totally independent of the resolution and depend only on the chosen value of the well depth, or examined region above threshold. With the realization that the $^1S/^3S$ energy-integrated cross section ratio is independent of ΔE, the ratio was measured from threshold to 0.12 eV. A typical spectrum is shown and corresponds to W = 0.008 V. The ratio is 4.2. 5 references. (JFP)

3715 (BNL—26765) **Cluster effects on charge state distributions for heavy ion molecular beams.** Thieberger, P. (Brookhaven National Lab., Upton, NY (USA)). 1979. Contract EY-76-C-02-0016. 11p. Dep. NTIS, PC A02/MF A01.

The charge-state distributions of ions emerging from carbon foils were compared for equal velocity monoatomic negative ions incident on the foil. Such comparisons were performed for O_2^- vs O^- and for C_3^- vs C^- and C_4^- vs C^-. Measured charge state distributions are shown for carbon and oxygen respectively and how the observed effect varies with foil thickness for the oxygen case. In all cases, the distribution is shifted toward lower average charge states for the molecular beams and the effect persists even though attenuated up to and including the thickest foils used. The most straightforward interpretation of these results is that for each component of the cluster there are more correlated electrons available for pickup than for single ions. 1 reference. (JFP)

3716 (IS—4694) **APES: a FORTRAN program to analyze photoelectron spectra.** Luly, M.H. (Ames Lab., IA (USA)). May 1979. Contract W-7405-ENG-82. 54p. Dep. NTIS, PC A04/MF A01.

A technique for making smoothing, baseline, and scattering corrections on photoelectron spectra is described, along with fitting the corrected spectra with a linear combination of Gaussian and Cauchy functions. The results are useful in inferring structural information. A FORTRAN IV computer program which implements the corrections and fitting is presented. 4 figures.

3717 (UCID—18287) **Atomic coherence created by a pulsed dye laser.** Scarl, D. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 3 Oct 1979. Contract W-7405-ENG-48. 5p. Dep. NTIS, PC A02/MF A01.

Level population as a function of laser pulse envelope area for an atom which could be approximated as a two level system was measured. An ideal two-level system under the action of an oscillating force is one of a few quantum mechanical systems for which the time-dependent Schroedinger equation can be solved exactly. The solution predicts that the population of the upper state, for a system which was entirely in the lower state at t = 0, varies as $\sin^2 A$, where $A = \int_0 /\sup\ t/\ \Omega(t)\, dt$, and $\Omega = e\, \epsilon_0(t)\, \chi_{12}/h\text{-bar}$.

3718 **Factor group splittings in the molecular vibrations of crystalline phenol.** Tripathi, G.N.R. (Radiation Laboratory, University of Notre Dame, Notre Dame, Indiana 46556). *J. Chem. Phys.;* **71**: No. 10, 4025-4033(15 Nov 1979).

Evidence for dynamic coupling in the molecular vibrations of crystalline phenol, a hydrogen bonded polymer, has been obtained for the first time. The factor group splittings in the vibrational spectra are resolved and interpreted on the basis of the orthorhombic symmetry approximation of the space group. The crystal frequencies are classified into symmetry species B_1 and B_2 of the D_2 factor group, having dipole moment vectors along the crystal axes a and b, respectively. The relation between the polarization behavior of the multiplet components and the symmetry species of the internal modes has been established. Some of the vibrational assignments are discussed.

3719 **Behavior of unstable atoms in applied fields.** Low, F.E. (Center for Theoretical Physics, Laboratory for Nuclear Science and Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Phys. Rev., A;* **20**: No. 4, 1567-1572(Oct 1979).

The leading radiative corrections to the behavior of atoms in time-dependent electromagnetic fields are considered. The results are expressed in closed form for the resonant measurement of the Lamb shift and fine structure of the n=2 levels of hydrogen.

3720 **uv laser induced molecular multiphoton ionization and fragmentation.** Rockwood, S.; Reilly, J.P.; Hohla, K.; Kompa, K.L. (Max-Planck-Gesellschaft zur Foerderung der Wissenschaften eV, Garching, Germany). *Opt. Commun.;* **28**: No. 2, 175-178(Feb 1979).

It has been demonstrated that the output from a discharge pumped KrF laser (249 nm) is capable of ionizing a variety of molecules. The nature and yield of ions generated in this process, which were identified by time-of-flight mass spectrometry, exhibit a striking intensity dependence. 12 references, 3 figures.

3721 **Energy levels, wavelengths, and transition probabilities of Cu-like ions.** Cheng, K.; Kim, Y. (Argonne National Laboratory, Argonne, Illinois 60439). *At. Data Nucl. Data Tables;* **22**: No. 6, 547-563(Dec 1978).

Wavelengths, oscillator strengths, and transition probabilities for the electric dipole transitions between low-lying states (n=4, 5, 6) of Cu-like ions are presented. The data are calculated from relativistic Hartree—Fock wavefunctions.

POSITRONIUM, MUONIUM, AND MUONIC AND MESIC ATOMS AND MOLECULES

REFER ALSO TO CITATION(S) 3820

COLLISION PHENOMENA

REFER ALSO TO CITATION(S) 3713, 3714

3722 (ANL—78-65(Pt.1), pp 98-104) **Electron scattering from N_2 below 30 eV. Rotationally-inelastic and momentum-transfer cross sections.** Siegel, J.; Dehmer, J.L.; Dill, D. 1978.

In Radiological and Environmental Research Division annual report: fundamental molecular physics and chemistry, October 1977-September 1978.

The calculation of rotationally inelastic collisions and momentum-transfer cross sections is treated for N_2. The rotationally inelastic differential, integrated, as well as the momentum-transfer cross sections are presented. 18 references. (JFP)

3723 (ANL—78-65(Pt.1), pp 105-108) **Electron-dipolar molecule scattering: LiF.** Siegel, J.; Dehmer, J.L.; Dill, D. 1978.

In Radiological and Environmental Research Division annual report: fundamental molecular physics and chemistry, October 1977-September 1978.

The complex rotational close-coupling or frame transformation calculations for electron collisions with LiF were previously simplified making it possible to base such calculations on the continuum multiple-scattering treatment of the core region. The first two simplifications were implemented to calculate e^- - LiF scattering at 5.44 eV. Body - frame calculations were performed using the continuum multiple-scattering method. Differential cross sections were calculated and are shown for rotational transitions at 5.44 eV. 12 references. (JFP)

3724 (ANL—78-65(Pt.1), pp 119-121) **Electron scattering from active nitrogen: excitation of the $3s^4P$ and $2p^4\ ^4P$ states of atomic nitrogen.** Spence, D.; Burrow, P.D. 1978.

In Radiological and Environmental Research Division annual report: fundamental molecular physics and chemistry, October 1977-September 1978.

An attempt was made to make measurements on electron scattering from atomic nitrogen close to threshold. Typical spectra and excitation cross sections are shown and their characteristics including indications of a resonance close to threshold are discussed. It is noted that due to the extreme difficulty in producing targets of atomic nitrogen such cross sections have not been previously obtained. The apparatus and its operation are described. 4 references. (JFP)

3725 (ANL—78-65(Pt.1), pp 122-124) **Resonances in the differential elastic scattering of electrons from mercury at 180°.** Burrow, P.D.; Michejda, J.A. 1978.

In Radiological and Environmental Research Division annual report: fundamental molecular physics and chemistry, October 1977-September 1978.

The lowest Feshbach resonances formed by electron scattering from Hg are observed in the total scattering cross section and in the differential elastic cross section at a scattering angle of 180°.

3726 **Intermediate-coupling collision strengths for P-P and P-D transitions produced by electron impact on highly charged He-like ions.** Clark, R.E.H.; Sampson, D.H. (Department of Astronomy, The Pennsylvania State University University Park, Pennsylvania 16802).

EY-76-502-2897.A002. *At. Data Nucl. Data Tables;* **22**: No. 6, 527-546(Dec 1978).

Intermediate-coupling collision strengths have been calculated by a Coulomb—Born—Exchange method for all fine-structure transitions between states of the 1s2p configuration and those of the 1snp and 1snd configurations with n=3,4, and 5 produced by electron impact on He-like ions with nuclear charge number Z in the range 8< or =Z< or =50. For each transition results are given for impact electron energies equal to 1.0, 1.2, 1.5, 1.9, 2.5, and 4.0 times threshold. Transition energies are provided for use in converting the impact electron energies to energies in rydbergs.

3727 (CONF-790950—1) **Electron capture by multicharged ions colliding with atomic hydrogen.** Crandall, D.H. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 9p. Dep. NTIS, PC A02/MF A01.

From International seminar on ion-atom collisions (ISIAC VI); Tokai-mura, Japan (6 Sep 1979).

A survey is given of electron capture by multicharged ions colliding with atomic hydrogen including a brief history of the research, experimental techniques, and the results and comparisons. Several cross sections are plotted. 44 references. (JFP)

3728 (COO—4022-2) **Cross sections and equilibrium fractions of deuterium ions and atoms in metal vapors. Progress report, June 1, 1978-May 31, 1979.** Morgan, T.J. (Wesleyan Univ., Middletown, CT (USA)). 1979. Contract EY-76-S-02-4022. 8p. Dep. NTIS, PC A02/MF A01.

The purpose of this program is to measure cross sections and equilibrium fractions of deuterium ions and atoms in metal vapors. In particular, in connection with double charge exchange D^- ion sources, there is concern with D^- formation in alkaline-earth vapor targets. Also, in connection with possible metal vapor contamination in the system, there is concern with cross sections for high energy D^+, D^0 and D^- collisions with these metal vapors. Results from this research will fill in a gap in knowledge of single and double charge transfer and multiple collision processes in alkaline-earth targets and provide a better understanding of D^- formation mechanisms. A list of publications is included. 6 references.

3729 (ORNL—5427, pp 27-37) **Chemical physics.** Garrett, W.R.; Allman, S.L.; Barnawell, H.L. Aug 1978.

In Health and Safety Research Division progress report for period ending April 30, 1978.

Progress over the past year is reported under eight headings: (1) Energy Pathways in Irradiated Gases, (2) Resonance Ionization Spectroscopy Experiments and One-Atom Detection, (3) Resonance Ionization Spectroscopy Experiments with Molecules, (4) Studies of Molecular Clustering Phenomena, (5) Collisional Ionization, (6) Multiphoton Spectroscopy of Molecules, (7) Theoretical Atomic and Molecular Studies, and (8) Theory of Laser Interaction with Quantum Systems. The descriptive material is limited to include only research highlights under each of these headings. However, for the interested reader, detailed accounts of the research summarized herein can be found in the papers that are referenced in this chapter.

3730 **Elastic electron scattering by CO_2, OCS, and CS_2 from 0 to 100 eV.** Lynch, M.G.; Dill, D.; Siegel, J.; Dehmer, J.L. (Department of Chemistry, Boston University, Boston, Massachusetts 02215). *J. Chem. Phys.;* **71**: No. 11, 4249-4254(1 Dec 1979).

The integrated elastic electron scattering cross sections for CO_2, OCS, and CS_2 were calculated from 0 to 100 eV using the continuum multiple-scattering model with the Hara exchange approximation. For each molecule, a strong π-type shape resonance occurs between ~1—4 eV, followed by multiple, weakly resonant features at higher kinetic energy. The latter are only marginally observable in the integrated cross section, but, in some cases, should be clearly observable in vibrational excitation spectra. Agreement with available experimental information is good for all three cases, except for a gross underestimation of the background (nonresonant) scattering cross section in OCS resulting from our omission of dipole scattering in this work.

3731 **Monte Carlo trajectory study of Ar+H_2 collisions: Thermally averaged vibrational transition rates at 4500 °K.** Duff, J.W.; Blais, N.C.; Truhlar, D.G. (University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *J. Chem. Phys.;* **71**: No. 11, 4304-4320(1 Dec 1979).

Quasiclassical trajectory calculations of vibrational transition rates in Ar+H_2 collisions have been carried out. A realistic potential energy surface has been used, and the rates are averaged over rotational—translation distributions at 4500 °K. The same transition rates are calculated by eight distorted-wave-based theories which have been used by others for various applications. The present calculations provide a critical test of these theories, especially for high vibrational quantum numbers where data has been scarce. We also discuss dissociation rates, the rotational component of vibrational energy transfer, and a surprisal analysis of the vibrational transition rates.

3732 **Single and double electron capture in the independent-electron approximation at high velocities.** Theisen, T.C.; McGuire, J.H. (Department of Physics, Kansas State University, Manhattan, Kansas 66502). *Phys. Rev., A;* **20**: No. 4, 1406-1408(Oct 1979).

Cross sections have been computed for single and double electron transfer from the ground state of a helium atom to the ground state of an α particle at high velocities by means of the independent-electron approximation with the Bates—Born version of first-order perturbation theory. Results are in reasonable agreement with experiment for both single and double electron capture.

3733 **Resonant dissociation of N_2 by electron impact.** Spence, D. (Argonne National Lab., IL); Burrow, P.D. *J. Phys., B (London);* **12**: No. 5, L179-L184(1979).

An electron impact process leading to the dissociation of molecular nitrogen through the intermediate formation of a temporary negative ion is described. The process is observed by detection of a narrow band of slow electrons ejected from $N^-(^3P)$. The cross section for dissociation has a vertical onset just above the dissociation limit of N_2 and reaches a peak value of 2.5×10^{-18} cm^2 +- 50%. 3 figures.

3734 **Influence of reactant vibrational excitation on the $O(^3P) + O_3$ biomolecular reaction rate** West, G.A. (Brookhaven National Lab., Upton, NY); Weston, R.E. Jr.; Flynn, G.W. *Chem. Phys. Lett.;* **56**: No. 3, 429-433(15 Jun 1978).

Atomic resonance fluorescence was used to monitor the disappearance rate of oxygen atoms in the presence of vibrationally excited ozone produced by a pulsed CO_2 laser. an upper limit was determined for the rate coefficient of the $O(^3P) + O_3$ bimolecular reaction. Comparison with a previously measured rate coefficient for deactivation of O_3 by $O(^3P)$ indicates that at most a small fraction (< 30%) of the O_3 relaxation is due to the laser-enhanced reaction. 37 references, 2 figures.

ATOMIC AND MOLECULAR THEORY

REFER ALSO TO CITATION(S) 3560

3735 (ANL—78-65(Pt.1), pp 56-58) **Comprehensive dipole oscillator strength distribution for N_2.** Wallace, S.; Kosman, W.; Dehmer, J.L.; Dill, D. 1978.

In Radiological and Environmental Research Division annual report: fundamental molecular physics and chemistry, October 1977-September 1978.

A preliminary account is presented of effort to compute the first comprehensive, ab initio dipole oscillator strength distribution for a molecule, using the continuum multiple-scattering method. 6 references.

3736 (ANL—78-65(Pt.1), pp 64-67) **Photoelectron branching ratios and angular distributions for all shells of selected molecules.** Wallace, S.; Dill, D.; Dehmer, J.L. 1978.

In Radiological and Environmental Research Division annual report: fundamental molecular physics and chemistry, October 1977-September 1978.

Extensive theoretical calculations of photoelectron branching ratios and angular distributions were performed for all shells of several molecules. An illustrative example from this work is given.

3737 (ANL—78-65(Pt.1), pp 91-94) **Shape resonances in electron scattering from small hydrocarbons: C_2H_4.** Siegel, J.; Dehmer, J.L.; Dill, D. 1978.

In Radiological and Environmental Research Division annual report: fundamental molecular physics and chemistry, October 1977-September 1978.

Preliminary results for shape resonances in low energy electron scattering by ethylene are studied. Eigenphase sums and cross sections are plotted. 10 references. (JFP)

3738 (UCRL—52645) **ATOMLLL: a three-D opaque molecule system (Lawrence Livermore Laboratory version).** Max, N.L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 11 Jan 1979. Contract W-7405-ENG-48. 39p. Dep. NTIS, PC A03/MF A01.

The program ATOMLLL draws color, shaded, hidden-surface pictures and movies of ball-and-stick and space-filling molecular models. From a file containing the colors and radii of the atoms, the coordinates of their centers, and the descriptions of bonds, if any, the program computes the visible portions of each atom. ATOMLLL then writes their descriptions into a file that can be copied to tape. The tape is read by a Varian minicomputer, which controls the plotting on the Dicomed D-48 color-film recorder. 1 reference.

3739 **Quantitative comparison of multiple-photon absorption in polyatomic molecules.** Judd, O.P. (University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *J. Chem. Phys.;* **71**: No. 11, 4515-4530(1 Dec 1979).

A quantitative comparison of multiple-photon absorption for a number of polyatomic molecules has been performed. A basis for this comparison has been developed that takes into account the different experimental conditions and molecular parameters, and provides suitable normalization of the fluence and absorption parameters. The normalization, and consequently the generalized interaction process, can be specified in terms of the spectroscopic absorption cross section of the molecule $\sigma_0(\nu)$ and effective fraction of molecules that interact with the radiation field $<f>$. The results of the study indicate that in terms of the normalized absorption variables, multiple-photon absorption is a general phenomenon that is qualitatively the same for all molecules; quantitative differences can be related to differences in σ_0 and $<f>$. The absorption of all polyatomic molecules can be described in terms of the number of photons absorbed per molecule eta (Phi) at a fluence Phi. The data indicate that in spectral regions where $\sigma_0(\nu) >$ or ≈ 0.1 (max), eta (Phi) can be represented by the function Phi/sup γ/ where $\gamma = 1$ for $\sigma_0 Phi/<f> < 1$ and $\gamma \approx 2/3$ for $\sigma Phi/<f> > 1$. Quantitative values of $<f>$ and the functional dependence of eta (Phi) on the exerimental parameters such as gas pressure, optical bandwidth, and optical pulse duration are derived and shown to be in good agreement with experimental data for SF_6. These results are also compared with the anharmonic oscillator model for multiple-photon excitation of polyatomic molecules.

3740 Effective convergence to complete orbital bases and to the atomic Hartree—Fock limit through systematic sequences of Gaussian primitives. Schmidt, M.W.; Ruedenberg, K. (Ames Laboratory, U.S. Department of Energy, and Department of Chemistry, Iowa State University, Ames, Iowa 50011). *J. Chem. Phys.;* **71**: No. 10, 3951-3962(15 Nov 1979).

Optimal starting points for expanding molecular orbitals in terms of atomic orbitals are the self-consistent-field orbitals of the free atoms and accurate information about the latter is essential for the construction of effective AO bases for molecular calculations. For expansions of atomic SCF orbitals in terms of Gaussian primitives, which are of particular interest for applications in polyatomic quantum chemistry, previous information has been limited in accuracy. In the present investigation a simple procedure is given for finding expansions of atomic self-consistent-field orbitals in terms of Gaussian primitives to arbitrarily high accuracy. The method furthermore opens the first avenue so far for approaching complete basis sets through systematic sequences of atomic orbitals.

3741 Shape-resonance—enhanced nuclear-motion effects in molecular photoionization. Dehmer, J.L.; Dill, D.; Wallace, S. (Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev. Lett.;* **43**: No. 14, 1005-1008(1 Oct 1979).

Shape in molecular photoionization are shown to induce strong coupling between vibrational and electronic motion over a spectral range several times broader than the resonances half-width of the resonances. This coupling is manifested by large deviations from Franck-Condon intensity distributions and strong dependence of photoelectron angular distributions on the vibrational state of the residual ion. The effects are illustrated for the 3σ/sub g/ photoionization channel of N_2.

3742 "Multiple-" versus "multi-" photon absorption in the theory of resonant ionization. Ritchie, B. (Chemical Physics Section, Health and Safety Research Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Phys. Rev., A;* **20**: No. 4, 1734-1737(Oct 1979).

The author has identified his result for resonant ionization by the simultaneous absorption of two photons by a ground-state electron [Phys. Rev. A 17, 659 (1978)] with the high-laser-power large-intermediate-state ionization rate result derived by Eberly and coworkers using a steady-state rate theory. This result gives $R\sigma_{22}$ for all power levels considered, where R is the one-photon ionization rate for the intermediate state and σ_{22} is its steady-state population factor. The result can be cast in this form, but it is found that σ_{22} must be much less than σ_{11}, the ground-state population factor. Thus the resonant process can be described by a rate limit for conserving energy by simultaneous absorption only when the ground-state population factor remains unity to order Ω^2/R^2, where Ω is the Rabi rate for the bound-bound transition. In other words, the simultaneous and sequential processes are physically equivalent in this limit.

GENERAL FLUID DYNAMICS

REFER ALSO TO CITATION(S) 3862

PARTICLE INTERACTIONS AND PROPERTIES - EXPERIMENTAL

ELECTROMAGNETIC INTERACTIONS

REFER ALSO TO CITATION(S) 3843

3743 (ORO—3992-364) Background to neutrino counting in e^+e^- collisions. Dicus, D.A. (Texas Univ., Austin (USA). Center for Particle Theory). Jun 1979. Contract EY-76-S-05-3992. 19p. Dep. NTIS, PC A02/MF A01.

The background from $e^+e^- \rightarrow 3\gamma$ to the proposed neutrino counting process of $e^+e^- \rightarrow \gamma\ \nu$ anti ν is calculated. It is shown that at PEP or PETRA beam energies the 3γ cross section is at least three orders of magnitude greater than the $\gamma\ \nu$ anti ν cross section. At higher beam energies, near the Z pole, the $\gamma\ \nu$ anti ν cross section is larger than the background but other ambiguities may make a determination of the number of types of neutrinos very difficult. 9 references.

3744 Measurement of the neutron magnetic moment. Greene, G.L.; Ramsey, N.F.; Mampe, W.; Pendlebury, J.M.; Smith, K.; Dress, W.B.; Miller, P.D.; Perrin, P. (Harvard University, Cambridge, Massachusetts 02138). *Phys. Rev., D;* **20**: No. 9, 2139-2153(1 Nov 1979).

The neutron magnetic moment μ/sub n/ has been measured with an improvement of 2 orders of magnitude in experimental accuracy. The separated-oscillatory-field magnetic resonance technique was employed using slow neutrons and protons (in flowing water) in the same magnetic field. We find the ratio of neutron to proton moment to be μ/sub n//μ/sub p/ = -0.684 979 35(17) (0.25 ppm). Expressed in Bohr magnetons μ/sub B/ this gives μ/sub n//μ/sub B/ = -1.041 875 64(26) x 10^{-3}. Expressed in nuclear magnetons μ/sub N/, μ/sub n//μ/sub N/ = -1.913 041 84(88).

WEAK INTERACTIONS

3745 (FERMILAB-CONF—79/32-EXP) Ultra-high-energy inelastic neutrino: nucleon scattering in DUMAND. Roberts, A. (Fermi National Accelerator Lab., Batavia, IL (USA)). May 1979. Contract EY-76-C-02-3000. 7p. (CONF-790836—6). Dep. NTIS, PC A02/MF A01.

From 16. international cosmic rays conference; Kyoto, Japan (6 Aug 1979).

The problems involved in designing an experiment using cosmic-ray neutrinos to measure the y-distribution in neutrino scattering at 2 to 50 TeV, which should be capable of demonstrating the existence of the W through its propagator effect on the y-distribution is discussed in detail. 19 references.

3746 Tests for observing ν/sub tau/ interactions in a beam-dump experiment. Albright, C.H.; Shrock, R.; Smith, J. (Fermi National Accelerator Laboratory, Batavia, Illinois 60510). *Phys. Rev., D;* **20**: No. 9, 2177-2197(1 Nov 1979).

We carry out a comparative analysis of three tests for the purpose of observing /sup(/nu-bar)/sup //sub tau/ in a beam-dump experiment. The main source of /sup(/nu-bar)/sup //sub tau/'s is determined to be the hadronic production of F mesons, followed by the decay $F^{+-} \rightarrow$ tau^{+-}/sup(/nu-bar)/sup //sub tau/. Possible signatures for various /sup(/nu-bar)/sup //sub tau/-induced processes, together with their corresponding backgrounds, are examined. The muon-trigger test proposed earlier is found to be by far the most promising method. This test identifies /sup(/nu-bar)/sup //sub tau/ events by the muonic decay mode of the tau^{+-} produced in /sup(/nu-bar)/sup //sub tau/ charged-current interactions, together with the requirements of substantial missing transverse momentum and distinctive behavior of certain azimuthal-angle distributions describing the emission of the muon, hadron shower, and direction of missing transverse momentum. It can be applied on an event-by-event basis, can separate ν/sub tau/- and nu-bar/sub tau/-induced reactions, and is specific to /sup(/nu-bar)/sup //sub tau/. One should be able to use the test to determine directly whether ν/sub tau/ is, indeed, a new, sequential neutrino. The test relies on the ability of recently developed neutrino detectors to measure the direction of the hadron shower. In addition to this muon-trigger test, we study the possibility of using two others, one based on the identification of events with two hadron showers, due to the semileptonic decay of the produced tau, and the other based on the apparent neutral-to-charged-current event ratio. We find that neither of these two other tests seems feasible. However, it is expected that the muon-trigger test can be used in the near future to observe, for the first time, ν/sub tau/ and nu-bar/sub tau/.

STRONG BARYON-INDUCED INTERACTIONS

3747 (ANL-HEP-CP—79-24) Nucleon-nucleon resonances. Auer, I.P. (Argonne National Lab., IL (USA)). 1979. Contract W-

31-109-ENG-38. 10p. (CONF-790847—13). Dep. NTIS, PC A02/MF A01.

From International conference on high energy physics and nuclear structure; Vancouver, Canada (13 Aug 1979).

The experimental techniques related to NN resonance measurements are described. The technique used is the good geometry transmission experiment. The basic idea is to measure the difference in the attenuation factor for the corresponding difference between the total cross sections of N + N interactions for forward and reverse momentum as a function of the solenoid current. 26 references. (JFP)

3748 Neutral-particle production in π^-p interactions at 147 GeV/c and comparison to charged-particle production. Brick, D.; Fong, D.; Heller, M. (Brown University, Providence, Rhode Island 02912). *Phys. Rev., D;* **20**: No. 9, 2123-2134(1 Nov 1979).

The production of K/sub S/, Λ, Lambda-bar, and γ in π^-p collisions at 147 GeV/c is analyzed. Cross sections, rapidity, Feynman-x, and p/sub T/ ^{2} distributions are presented and compared to charged-particle production. The energy dependence of multiplicities in π^-p and pp collisions is shown. A new scaling form for the correlation of neutral- and charged-particle multiplicities is presented for compilations of πp and pp data.

3749 Slow-proton production from neutron targets at 100 and 400 GeV/c. Hanlon, J.; Brody, A.; Kafka, T.; Sommars, S.; Lys, J.E.A.; Murphy, C.T.; Barish, S.J.; Dado, S.; Engler, A.; Kraemer, R.W. (State University of New York at Stony Brook, Stony Brook, New York 11794). *Phys. Rev., D;* **20**: No. 9, 2135-2138(1 Nov 1979).

We study the production of slow protons from neutron targets in the reaction p+n → p+X at 100 and 400 GeV/c and in the reaction π^+ +n → p+X at 100 GeV/c in the kinematic region vertical-bartvertical-bar < 1.0 GeV^2. The data are observed to scale as a function of M^2/s and t. We extract an effective Regge trajectory from the pn data of α/sub eff/ (t) = (0.26 +- 0.04)+(1.07 +- 0.11) t and obtain a similar result with the π^+n data. We conclude that Reggeized one-pion exchange alone is not sufficient to describe these reactions.

3750 Spin-spin forces in 6-GeV/c neutron-proton elastic scattering. Crabb, D.G.; Hansen, P.H.; Krisch, A.D.; Shima, T.; Terwilliger, K.M.; Crosbie, E.A.; Ratner, L.G.; Schultz, P.F.; Thomas, G.H.; O'Fallon, J.R.; Lin, A.; Salthouse, A.L.; Perlmutter, A. (Randall Laboratory of Physics, The University of Michigan, Ann Arbor, Michigan 48109). *Phys. Rev. Lett.;* **43**: No. 14, 983-986(1 Oct 1979).

Measurement was made of dσ/dt for n/sub arrow-up/+p/sub arrow-up/→n+p at P/sub perpendicular/^{2}=0.8 and 1.0(GeV/c)^2 at 6 GeV/c. The 6-GeV/c 53%-polarized neutrons from the 12-GeV/c polarized deuteron beam at the Argonne zero-gradient synchroton were scattered from our 75%-polarized proton target. Both spins were oriented perpendicular to the scattering plane. We found large unexpected spin-spin effects in n-p elastic scattering which are quite different from the p-p spin-spin effects.

STRONG MESON-INDUCED INTERACTIONS

REFER ALSO TO CITATION(S) 3748, 3749, 3801

3751 Many-pion production in π^+d reactions at 15 GeV/c. Hagopian, V.; Gluch, D.; Hagopian, S.; Horne, C.P.; Jenkins, M.; Lannutti, J.E.; Williams, P.K.; Wind, B.; Cohn, H.O.; Bugg, W.M.; Condo, G.T.; Handler, T.; Hart, E.L. (Florida State University, Tallahassee, Florida 32306). *Phys. Rev., D;* **20**: No. 9, 2113-2122(1 Nov 1979).

The average number of charged pions produced in π^+d reactions at 15-GeV/c π^+ momentum is 3.6 +- 0.1 and the average number of π^0's is 1.9 +- 0.2. The average number of π^0's produced is essentially independent of the number of charged pions. About 45% of the events have four or more charged pions in the final state. The exclusive final states with four or more charged pions with zero or one π^0 are presented and compared with modified phase-space background computations. Other than the well-known resonances, such as the rho^0, no new peaks have been observed. Coherently produced multipion systems with up to seven pions are also discussed. Detailed cross-section information for every final state is presented.

PARTICLE INTERACTIONS AND PROPERTIES - THEORETICAL

GENERAL

REFER ALSO TO CITATION(S) 3855

ELECTROMAGNETIC INTERACTIONS

REFER ALSO TO CITATION(S) 3766, 3774, 3781, 3843

3752 Weak corrections to three-jet angular distributions in e^+e^- interactions. Rizzo, T.G. (Department of Physics, Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev., D;* **20**: No. 9, 2248-2252(1 Nov 1979).

We examine the effects of a parity- and charge-conjugation-violating neutral-current interaction on the angular distributions of three-jet final states in e^+e^- interactions. To do this, we examine the correlations C_1 equivalent <q (e^-) x p/sub q/> and C_2 equivalent <q (e^-) x (p/sub q/ x p/sub q/) > with p/sub q/ (p/sub q/) being the quark- (antiquark-) jet momentum. Note that since C_2 is a pseudoscalar a nonzero value would be a clear indication of parity-violating neutral currents. We find the value of C_1 to be comparable to that found for two jets and C_2 to be of order ~ m/sub q/ ^{2}/s with m/sub q/ being the mass of the final-state quark and, hence, very small.

3753 Majorana-lepton-mediated μ^- to e^+ conversion in nuclei. Kamal, A.N.; Ng, J.N. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). *Phys. Rev., D;* **20**: No. 9, 2269-2277(1 Nov 1979).

We estimate the branching ratio of the anomalous conversion of μ^- to e^+ in nuclei via the exchange of a virtual Majorana lepton to ordinary muon capture to be $<10^{-13}$ for a 0.5-GeV/c^2 lepton and $<10^{-14}$ for a 1.0-GeV/c^2 lepton. A sequential Weinberg-Salam gauge model with four lepton doublets and neutrino mixing is used. The change in the anomalous capture rate with respect to the mass of the Majorana lepton is also discussed.

WEAK INTERACTIONS

REFER ALSO TO CITATION(S) 3752, 3753, 3773, 3774

3754 (BNL—26498) Weak neutral current: a determination of its structure and an analysis of the error due to theoretical and experimental uncertainties. Langacker, P.; Kim, J.E.; Levine, M.; Williams, H.H.; Sidhu, D.P. (Pennsylvania Univ., Philadelphia (USA); Brookhaven National Lab., Upton, NY (USA)). 1979. Contract EY-76-C-02-0016. 36p. (CONF-790648—7). Dep. NTIS, PC A03/MF A01.

From Neutrino 1979 conference; Bergen, Norway (18 Jun 1979).

The most recently available neutral current data, together with previous measurements, was used to determine in a model independent way the structure of the hadronic and leptonic neutral currents. In the theoretical treatment of ν deep inelastic scattering, the effects of quantum chromodynamics, including the contribution of s and c quarks were evaluated. 64 references. (JFP)

3755 (FERMILAB-CONF—78/95-EXP) Monte Carlo simulation of inelastic neutrino scattering in DUMAND. Roberts, A. (Fermi National Accelerator Lab., Batavia, IL (USA)). Dec 1978. Contract EY-76-C-02-3000. 17p. Dep. NTIS, PC A02/MF A01.

Detailed Monte Carlo calculations simulating the detection in the DUMAND 1-km^3 optical detector of inelastic neutrino scattering by nucleons at 2 TeV and above show that the measurement of the y distribution is subject to systematic errors due to experimental errors and intrinsic fluctuations which produce errors in the energy determinations of hadronic cascade and muon; uncertainty in the exact amount of antineutrino fraction in the cosmic-ray neutrino flux. The nature of these errors is explored, and methods for removing them from the data developed. The remaining uncertainties are those in the evaluation of the errors in energy determination, and in the antineutrino contamination. It appears that these errors, not statistical ones, will eventually govern the accuracy of the y distributions obtained. Nonetheless, the effect of the boson propagator on the y distribution is so marked that no plausible scenario can be found in which the residual errors cast doubt on whether or not the propagator effect is present.

3756 Quantum-chromodynamic corrections to parity-violating asymmetries in ep reactions at high Q^2. Rizzo, T.G. (Department of Physics, Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev., D;* **20**: No. 9, 2207-2212(1 Nov 1979).

We examine quantum-chromodynamic (QCD) corrections to the Q^2 and y dependence of various asymmetries in ep deep-inelastic scattering produced by the parity-violating weak neutral currents of the Weinberg-Salam model. We find, for Q^2 in the range 10 < or = Q^2 < or = 10^4 (GeV/c)^2, that a small change in the value of sin^{2}θ/sub W/ can mask the small (~ 5—10%) QCD corrections even if data are taken over the entire range of y. We conclude that QCD does not produce significantly large modifications to the weak asymmetries considered for the above range of Q^2.

3757 Effective Hamiltonian for ΔS=1 weak nonleptonic decays in the six-quark model. Gilman, F.J.; Wise, M.B. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). *Phys. Rev., D;* **20**: No. 9, 2392-2407(1 Nov 1979).

Strong-interaction corrections to the nonleptonic weak-interaction Hamiltonian are calculated in the leading-logarithmic approximation using quantum chromodynamics. Starting with a six-quark theory, the W boson, t quark, b quark, and c quark are successively considered as "heavy" and the effective Hamiltonian is calculated. The resulting effective Hamiltonian for strangeness-changing nonleptonic decays involves u, d, and s quarks and has possible CP-violating pieces both in the usual (V-A) x (V-A) terms and in induced, "penguin"-type terms. Numerically, the CP-violating compared to CP-conserving parts of the latter terms are close to results calculated on the basis of the lowest-order "penguin" diagram.

3758 Gluon correction to semileptonic decays of heavy quarks. Suzuki, M. (California Univ., Berkeley (USA). Dept. of Physics). *Nucl. Phys., B;* **145**: No. 2, 420-428(4 Dec 1978).

The lowest-order correction is calculated to the simple quark model of semileptonic heavy quark decays in quantum chromodynamics. The semileptonic decay rates are suppressed substantially, as much as 35% for the charmed quark, and the inclusive energy spectra of final quarks and leptons are softened enough to reproduce well the inclusive lepton spectrum observed for the charmed hadron decays.

STRONG INTERACTIONS, GENERAL

REFER ALSO TO CITATION(S) 3757, 3773

3759 Quantum chromodynamics (La Jolla Institute, 1978). Frazer, W.; Henyey, F. (eds.). New York, NY; American Institute of Physics (1979). 346p. (CONF-7808111—). Copyright Clearance Center, Inc., Box 765, Schenectady, NY 12301.

From La Jolla Institute workshop on quantum chromodynamics; La Jolla, CA, USA (Aug 1978).

Separate abstracts were prepared for the four lectures included in the seminar.

STRONG INTERACTIONS, BARYON NO.=0

3760 (CALT—63-294) Study of the pion stopping rate at the proposed target position in Cave C of the SMC. Progress report to LAMPF. Powers, R.; Vuilleumier, J.L.; Wang, K.C.; Kunselman, A.R. (California Inst. of Tech., Pasadena (USA); Wyoming Univ., Laramie (USA)). 1977. Contract EY-76-C-03-0063. 9p. Dep. NTIS, PC A02/MF A01.

This report documents the experimental studies of the pion stopping rates in Cave C (East Leg) of the SMC. It is part of the feasibility study for a crystal spectrometer experiment investigating pionic atoms (Exp. 173). Earlier findings and calculations can be found in the reports to LAMPF CALT-63-230 (March 1975), CALT-63-228 (May 1975), CALT-63-269 (August 1976) and CALT-63-278 (December 1976). Recently, the removal of the bending magnet BM phi 3 was recommended, and a report is given on tests of this channel configuration. The proton current was 260 nA. The tests were performed at two different proton energies, 650 and 800 MeV. The results are summarized in section B of this report. Section C gives the conclusion of the feasibility study.

3761 Multiplicity distributions of created bosons: the method of combinants. Kauffmann, S.K.; Gyulassy, M. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). *J. Phys., A (London);* **11**: No. 9, 1715-1727(Sep 1978).

The number of bosons that are created by an excitation process, in a system which initially has none, is a random variable having a discrete probability distribution, defined on the non-negative integers, which satisfies $P(0) > 0$. The logarithm of the resulting probability generating function is therefore analytic at the origin, and the series expansion co-efficients thereby generated can each be expressed as a finite combination of ratios of the P(n), giving them an interestingly close kinship to experimental data. These 'combinants' are additive for sums of boson multiplicity random variables which are independent, and they all vanish except for the first-order one (which has the value of the mean) in the important Poisson case. The combinants are readily calculated in a number of theoretical models for created boson multiplicities. The resulting boson multiplicity distributions are then described by the very general convoluted multiple Poisson distribution, which is expressed directly in terms of the combinants. Combinants thus provide a neat theoretical tool for dealing with many models of boson multiplicity distributions. It is further shown that cumulants have the same formal relation to combinants as moments have to probabilities.

STRONG INTERACTIONS, BARYON NO.=1

REFER ALSO TO CITATION(S) 3765, 3767, 3770

3762 Field theory of pion-nucleus interactions. Miller, G.A. (University of Washington, Seattle, Washington 98195). *AIP (Am. Inst. Phys.) Conf. Proc.;* **54**: No. 1, 561-575(15 Jul 1979). (CONF-790347—).

From 2. international conference on meson-nuclear physics; Houston, TX, USA (5 Mar 1979).

Some approximate solutions of the Low equations for pi-nucleon scattering, pi-nuclear scattering and the $pp \rightarrow d\pi^+$ reaction are discussed. Our results differ from those of other treatments by the inclusion of propagator modifications which act as cutoffs for terms involving pions of relatively small momenta. Because of these propagator modifications the use of a pi-nucleon T-matrix of long range is perfectly consistent with the idea that the fundamental pi-nucleon form factor is of very short range. The origin of these propagator modifications is shown to be a proper evaluation of the energy dependence of the off-shell pi-nucleon scattering amplitude. As a consequence of our theory, good agreement with $pp \rightarrow d\pi^+$ data is obtained without the inclusion of large effects from rho-meson exchnge terms.

3763 Properties of the elementary KN and KN interactions. Dover, C.B. (University of Pennsylvania, Philadelphia, Pennsylvania 19104). *AIP (Am. Inst. Phys.) Conf. Proc.;* **54**: No. 1, 634-657(15 Jul 1979). (CONF-790347—).

From 2. international conference on meson-nuclear physics; Houston, TX, USA (5 Mar 1979).

Kaon beams offer exciting prospects for the study of both nuclear and hypernuclear physics. Experiments on hypernucleus formation via the $(^-,\pi^-)$ reaction, as well as elastic and inelastic scattering of K^{+-} from nuclei, are already underway. The theoretical analysis of such experiments requires an understanding of the underlying two-body K^{+-} N interaction. We review here the main features of these elementary amplitudes, as revealed through phase shift analyses and meson exchange models. We indicate how the properties of the two body interaction (isospin dependence, Y* and Z* resonance formation, strangeness exchange, etc.) are reflected in reactions induced by kaons in nculei.

STRONG INTERACTIONS, BARYON NO. GREATER THAN 1

REFER ALSO TO CITATION(S) 3762, 3774

3764 Multipion production in nuclear collisions. Gyulassy, M. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *AIP (Am. Inst. Phys.) Conf. Proc.;* **54**: No. 1, 131-141(15 Jul '979). (CONF-790347—).

From 2. international conference on meson-nuclear physics; Houston, TX, USA (5 Mar 1979).

We discuss two aspects of multipion production in nuclear collisions: (1) the negative pion multiplicity distribution, and (2) the $\pi^-\pi^-$ correlation function. The emphasis is on how these observables could be used to search for signals of collective phenomena in nuclear collisions.

3765 (DOE/ER—01388-775) Field theory of pion-nucleus interactions. Miller, G.A. (Washington Univ., Seattle (USA)). 1979. Contract EY-76-C-06-1388. 7p. (RLO—1388-775; CONF-790242—1). Dep. NTIS, PC A02/MF A01.

From Annual conference of the American Institute of Physics; Houston. TX, USA (Feb 1979).

Some approximate solutions of the Low equations for pi-nucleon scattering, pi-nuclear scattering and the $pp \rightarrow d\pi^+$ reaction are discussed. Results differ from those of other treatments by the inclusion of propagator modifications which act as cutoffs for terms involving pions of relatively small momenta. Because of these propagator modifications the use of a pi-nucleon T-matrix of long range is perfectly consistent with the idea that the fundamental pi-nucleon form factor is of very short range. The origin of these propagator modifications is shown to be a proper evaluation of the energy dependence of the off-shell pi-nucleon scattering amplitude. As a consequence of the theory, good agreement with $pp \rightarrow d\pi^+$ data is obtained without the inclusion of large effects from rho-meson exchange terms. 22 references.

3766 (ORO—3992-357) Tests and predictions of the modified cascade model for hadron, photon, and lepton nucleus collisions. Hossain, M.; Tow, D.M. (Texas Univ., Austin (USA). Center for Particle Theory). Jan 1979. Contract EY-76-S-05-3992. 31p. Dep. NTIS, PC A03/MF A01.

The recently proposed space-time model, the modified cascade model, for hadron-nucleus collisions is investigated further and also extended to apply to photon and lepton nucleus collisions. Dependences of the multiplicity on incident particle, nucleus, rapidity, and energy, as well as the A dependences of the total inelastic cross sections, are calculated, with the model's only free parameter fixed by a normalization as determined previously. Results are compared and found to be in agreement with published experimental

data from p, π, K, μ, and ν nucleus collisions. Several representative predictions of the model are also presented. 29 references.

3767 (ORO—4928-T1) **Proposal for partial wave analyses of scattering reactions below 2 GeV. Technical progress report.** Arndt, R.A.; Roper, L.D. (Virginia Polytechnic Inst. and State Univ., Blacksburg (USA)). 1978. Contract EY-76-S-05-4928. 26p. Dep. NTIS, PC A03/MF A01.

It is proposed to continue efforts on the analysis of the reactions; NN → NN; PI N → PI N, $K^+p \rightarrow K^+p$ and PI N → PI PI N below 2 GeV. The continuation of development of computer programs and data bases at VPI and SU is further proposed which can be accessed through telephone lines from anywhere and which will display the predictions of analyses carried out under this proposal.

3768 **Spin effects in large-transverse-momentum exclusive scattering processes.** Brodsky, S.J.; Carlson, C.E.; Lipkin, H. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). *Phys. Rev., D;* **20**: No. 9, 2278-2289(1 Nov 1979).

Nucleon-nucleon scattering at large momentum transfer is analyzed within the framework of quantum-chromodynamic quark and gluon interactions. The spin dependence of the hadronic amplitude is found to be particularly sensitive to the underlying dynamical mechanisms. Detailed discussions of the quark-interchange and Landshoff pinch-singularity contributions are given for large-angle pp, np, and pp-bar elastic scattering. A possible explanation is given for the large spin-spin correlations measured by Crabb et al. We also define a new SU(2) symmetry group, H spin, which generalizes conventional helicity, and is an exact symmetry of the quark-interchange process.

3769 **Polarized proton-neutron total cross sections from proton-deuteron data.** Alberi, G.; Bleszynski, M.; Jaroszewicz, T.; Santos, S. (Istituto di Fisica Teorica, Universita di Trieste, Miramare Trieste, Italy). *Phys. Rev., D;* **20**: No. 9, 2437-2440(1 Nov 1979).

Simple expressions are derived for the polarized proton-deuteron total cross sections. These expressions are more complete than the ones given in a recent paper by Sorensen, because they include the contribution of the D wave of the deuteron. We discuss also the t dependence of the amplitudes in the double-scattering integral and the contribution of the real parts of the double-spin-flip amplitudes.

3770 **Hamiltonian model for nucleons, pions and Δ's.** Betz, M.; Lee, T.H.; Coester, F. (Argonne National Laboratory, Argonne, Illinois 60439). *AIP (Am. Inst. Phys.) Conf. Proc.;* **54**: No. 1, 610-611(15 Jul 1979). (CONF-790347—).

From 2. international conference on meson-nuclear physics; Houston, TX, USA (5 Mar 1979).

Within the framework of relativistic particle quantum mechanics, a model is constructed which describes the interactions between nucleons, pions and Δ's at low and medium energy. The parameters of the model are determined phenomenologically by fitting data of simple process involving these particles. The resulting Hamiltonian should be useful for many-body calculations in which pions may appear explicitly and Δ's are unstable.

PARTICLE INVARIANCE PRINCIPLES AND SYMMETRIES

GENERAL

REFER ALSO TO CITATION(S) 3780

3771 **Effective potential for non-Abelian gauge theories and spontaneous symmetry breaking.** Ovrut, B.A. (Department of Physics, Brandeis University, Waltham, Massachusetts 02154). *Phys. Rev., D;* **20**: No. 6, 1446-1459(15 Sep 1979).

We derive a formal expression for the one-loop corrected effective potential of non-Abelian gauge theory in the covariant gauge. This expression is checked, for arbitrary gauge group, by graphically calculating the one-loop renormalization constants. The effective potential for a restricted range of fields is explicitly evaluated for the gauge groups SU(2) and SU(3) in the Landau gauge. We extend the range of validity of these results using the renormalization group to improve the effective potential. Extension to larger, simple gauge groups follows immediately from our formalism. The possibility, and physical meaning, of a nonzero vacuum expectation value is discussed. A nonzero vacuum is shown to behave as a regulator for infrared divergences.

APPLICATIONS TO ELECTROMAGNETIC AND WEAK INTERACTIONS

REFER ALSO TO CITATION(S) 3752, 3753, 3756

FIELD THEORY

REFER ALSO TO CITATION(S) 3719, 3756, 3757, 3762, 3768, 3771

3772 (DOE/ER—01388-777) **Testing quantum chromodynamics in electron-positron annihilation at high energies.** Brown, L.S. (Washington Univ., Seattle (USA). Dept. of Physics). 1979. Contract EY-76-C-06-1388. 13p. (RLO—1388-777; CONF-790150—6). Dep. NTIS, PC A02/MF A01.

From Orbis scientiae 1979 conference; Coral Gables, FL, USA (15 Jan 1979).

Various measures of the distribution of hadronic energy produced in high energy electron-positron annihilation provide precise tests of the promising fundamental theory of hadronic physics, quantum chromodynamics. Recent work at the University of Washington on such energy cross sections is reviewed.

3773 (DOE/ER—01388-782) **Perturbative QCD: an overview.** Ellis, S.D. (Washington Univ., Seattle (USA). Dept. of Physics). 1979. Contract EY-76-C-06-1388. 9p. (RLO—1388-782; CONF-790163—3). Dep. NTIS, PC A02/MF A01.

From Orbis Scientiae; Miami, FL, USA (Jan 1979).

Recent progress in the utilization of perturbative quantum chromodynamics to study lepton-hadron and hadron-hadron reactions is reviewed. Interest is focused on the connections between the various results and the implications for the parton model as a phenomenological tool and as a vehicle to test quantum chromodynamics. 42 references.

3774 (SLAC-PUB—2395) **Nuclear phenomena and the short distance structure of hadrons.** Brodsky, S.J. (Stanford Linear Accelerator Center, CA (USA)). Sep 1979. Contract EY-76-C-03-0515. 47p. Dep. NTIS, PC A03/MF A01.

In certain cases, nuclear corrections to hadronic phenomena depend in detail on the nature of quark and gluon interactions, as well as the effects of jet development within the nuclear medium. Applications of quantum chromodynamics to fast particle production in nuclear collisions, nuclear form factors, and shadowing in deep inelastic lepton processes are reviewed. Also discussed is a new approach to particle production in hadron-nucleus, nucleus-nucleus and deep-inelastic nuclear reactions from the standpoint of a color-neutralization model. 74 references.

3775 **Coherent states for general potentials. I. Formalism.** Nieto, M.M.; Simmons, L.M. Jr. (Theoretical Division, Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87545). *Phys. Rev., D;* **20**: No. 6, 1321-1331(15 Sep 1979).

We first review the properties of the harmonic-oscillator coherent states which can be equivalently defined as (a) a specific subset of the x-p minimum-uncertainty states, (b) eigenstates of the annihilation operator, or (c) states created by a certain unitary exponential displacement operator. These definitions are not equivalent in general. Then we present a new method for finding coherent states for particles in general potentials. Its basis is the desire to find those states which most nearly follow the classical motion, but it is most nearly a generalization of the minimum-uncertainty method. The properties of these states are discussed in detail. Next we show that the annihilation operator and displacement operator methods, as heretofore defined, cannot be applied to general potentials (whose eigenvalues are not equally spaced). We define a generalization of these methods but show that the states so defined are not, in general, equivalent to the minimum-uncertainty coherent states. We discuss a number of properties of our coherent states and the procedures we have used.

3776 **Anharmonic analysis of lattice field theories.** Richardson, J.; Blankenbecler, R. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). *Phys. Rev., D;* **20**: No. 6, 1351-1359(15 Sep 1979).

A new calculational procedure for polynomial lattice field theories is discussed that utilizes an anharmonic basis and a general orthogonal transformation of coordinates. The standard blocking procedure is shown to correspond to a discrete Haar transform of the field coordinates. Some generalizations of the Haar transform are given which allow one to block an arbitrary number of sites. This is applied to both the energy density and to the correlation functions. In this paper only an "unperturbed" problem will be discussed, but the unperturbed Hamiltonian will be chosen using a variational principle: it includes couplings and nonharmonic effects in a very nontrivial way. Numerical results will be given for certain critical indices for a phi^4 theory in one space dimension.

3777 **Dual transformations: An equivalence between the continuum and lattice versions of thetwo-dimensional Abelian Higgs model.** Bardakci, K.; Rabinovici, E. (Department of Physics and Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *Phys. Rev., D;* **20**: No. 6, 1360-1368(15 Sep 1979).

The topological excitations in the two-dimensional Abelian Higgs model are studied in both the continuum and the Villain lattice version, and the results are compared. Using a singular gauge transformation, it is shown that there is an exact equivalence between the dual form of both versions. A fermion form of the theory is useful in studying its confinement properties beyond the dilute-gas limit. Also, the correct measure factor for the continuum version is derived.

3778 Multilegged propagators in strong-coupling expansions. Bender, C.M.; Cooper, F.; Guralnik, G.S.; Sharp, D.H.; Roskies, R.; Silverstein, M.L. (Department of Physics, Washington University, St. Louis, Missouri 63130). *Phys. Rev., D;* **20**: No. 6, 1374-1385(15 Sep 1979).

This paper is a continuation of a previous paper on strong-coupling expansions in quantum field theory. We are concerned here with one-dimensional quantum field theories (quantum-mechanical models). Our general approach is to derive graphical rules for constructing the strong-coupling expansion from a Lagrangian path integral in the presence of external sources. After reviewing the normalization of one-dimensional path integrals, we examine in detail the model Hamiltonian H = vertical-barpvertical-bar + vertical-barqvertical-bar. We show that in the strong-coupling expansion the graphs are constructed from multilegged propagators attached to multilegged vertices. We use these graphical rules to calculate the ground-state energy for this Hamiltonian. One motivation for examining expansions involving multilegged propagators is provided by the Lagrangian for quantum chromodynamics whose strong-coupling expansion also involves multilegged propagators.

3779 Fock-space description of the 1/N/sub c/ expansion of quantum chromodynamics. Thorn, C.B. (Center for Theoretical Physics, Laboratory for Nuclear Science and Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Phys. Rev., D;* **20**: No. 6, 1435-1441(15 Sep 1979).

We present a Fock-space formulation of the expansion of quantum chromodynamics in a power series in 1/N/sub c/, where N/sub c/ is the number of colors. We hope this formulation will aid spectrum calculations in the N/sub c/→∞ limit.

3780 Gribov ambiguity without topological charge. Henyey, F.S. (Department of Physics, B-019, University of California, San Diego, La Jolla, California 92093). *Phys. Rev., D;* **20**: No. 6, 1460-1462(15 Sep 1979).

Examples of gauge transform pairs of fields A (x), A′ (x) in non-Abelian gauge theories are constructed in which (1) both are in the Coulomb gauge, (2) both have zero topological charge, (3) both fall faster than 1/r at large r, and therefore occur in the compactified theory. These examples illustrate the fact that the Gribov ambiguity encompasses a larger variety of phenomena than those described by instantons.

3781 About coupling constant singularities in quantum electrodynamics. Litwin, C. (Stanford Linear Accelerator Center, CA (USA)). *Phys. Lett., B;* **80**: No. 3, 236-238(1 Jan 1979).

The contribution of the multibubble insertions in the photon propagator to the anomolous magnetic moment of the electron is reexamined. Using the asymptotic form of the photon propagator one finds a softer singularity than that found in a recent analysis.

SCATTERING THEORY

3782 (ORO—3992-358) **Resonances, scattering theory and rigged Hilbert spaces.** Parravicini, G.; Gorini, V.; Sudarshan, E.C.G. (Texas Univ., Austin (USA). Center for Particle Theory). Jan 1979. Contract EY-76-S-05-3992. 60p. Dep. NTIS, PC A04/MF A01.

The problem of decaying states and resonances is examined within the framework of scattering theory in a rigged Hilbert space formalism. The stationary free, in, and out eigenvectors of formal scattering theory, which have a rigorous setting in rigged Hilbert space, are considered to be analytic functions of the energy eigenvalue. The value of these analytic functions at any point of regularity, real or complex, is an eigenvector with eigenvalue equal to the position of the point. The poles of the eigenvector families give origin to other eigenvectors of the Hamiltonian; the singularities of the out eigenvector family are the same as those of the continued S matrix, so that resonances are seen as eigenvectors of the Hamiltonian with eigenvalue equal to their location in the complex energy plane. Cauchy theorem then provides for expansions in terms of complete sets of eigenvectors with complex eigenvalues of the Hamiltonian. Applying such expansions to the survival amplitude of a decaying state, one finds that resonances give discrete contributions with purely exponential time behavior; the background is of course present, but explicitly separated. The resolvent of the Hamiltonian, restricted to the nuclear space appearing in the rigged Hilbert space, can be continued across the absolutely continuous spectrum; the singularities of the continuation are the same as those of the out eigenvectors. The free, in and out eigenvectors with complex eigenvalues and those corresponding to resonances can be approximated by physical vectors in the Hilbert space, as plane waves can. The need for having some further physical information in addition to the specification of the total Hamiltonian is apparent in the proposed framework. The formalism is applied to the Lee-Friedrichs model. 48 references.

3783 (ORO—3992-360) **Cluster formulation in the dual topological unitarization.** Hossain, M. (Texas Univ., Austin (USA). Center for Particle Theory). Feb 1979. Contract EY-76-S-05-3992. 56p. Dep. NTIS, PC A04/MF A01.

The work of Chiu, Hossain, and Tow is generalized by incorporating the no double counting condition and the t/sub min/ effect in the integral equations for the Reggeon and the Pomeron. The relation between the no double counting condition and the average cluster separation is derived, and a test is proposed to determine the correct counting. It is shown that the t/sub min/ effect is quite important in determining the Regge parameters. The model predicts a relation between five physical quantities: the Pomeron intercept (α/sub p/^{0}) and slope (α/sub p/$'$), the magnitude (k) and the exponential dependence (b) of the triple-Regge vertex, and the ratio of Pomeron to Reggeon residues (c) at t = 0. The solutions obtained are well within the range of acceptable values. A reasonable solution is, for example, α/sub p/^{0} = .92, α/sub p/$'$ = .2, b = 1.6, k = 12.9, and c = 0.91. It is found that cuts are present in both the Reggeon and the Pomeron amplitudes, and their contributions are small compared to the leading poles. 27 references.

PHYSICS RESEARCH (CONT.)

NUCLEAR PHYSICS

3784 (ORO—3346-236) **Nuclear and x-ray spectroscopy with radioactive sources. Fifteenth annual progress report.** Rink, R.W.; Wood, J.L. (Georgia Inst. of Tech., Atlanta (USA). School of Chemistry). 31 Oct 1979. Contract EY-76-S-05-3346. 33p. Dep. NTIS, PC A03/MF A01.

Research during the year is summarized briefly for the following areas: nuclear spectroscopy (including nuclear systematics and models and experimental studies of heavy-nucleus decays), x rays from radioactive sources (including L-subshell x-ray fluorescence and Coster-Kronig yields and the measurement of tailing corrections in low-energy coincidence intensity determinations), and miscellaneous topics concerning computer codes and equipment. One may assume publication of completed work in the usual channels. Lists of personnel, publications, etc., are included. 7 figures. (RWR)

EXPERIMENTAL TECHNIQUES

3785 (CONF-790976—1) **Plans for laser hyperfine structure measurement at UNISOR.** Carter, H.K.; Bingham, C.R. (Oak Ridge Associated Universities, Inc., TN (USA); Tennessee Univ., Knoxville (USA)). 1979. Contract W-7405-ENG-26. 6p. Dep. NTIS, PC A02/MF A01.

From International symposium on future directions in studies of nuclei far from stability; Nashville, TN, USA (10 Sep 1979).

In April 1978, the UNISORR executive committee requested a study be done on the feasibility of optical spectroscopy experiments at UNISO in order to determine nuclear spins, moments and changes in the root-mean-square charge radius ($\delta < r^2 >$). The study showed that it is indeed feasible to perform these measurements on many new isotopes which are produced at UNISOR. Subsequently, plans were made for the development of such a facility and funds were obtained for the capital equipment. A brief review of the technique is given with the details for the experimental procedure we intend to implement. The resolution and sensitivity expected at UNISOR is discussed.

NUCLEAR PROPERTIES AND REACTIONS, A=1-5, THEORETICAL

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 3787

NUCLEAR REACTIONS AND SCATTERING

3786 Mesonic exchange current effects in elastic electron-deuteron scattering. Lomon, E.L. (Center for Theoretical Physics, Labo-

ratory for Nuclear Science and Department of Physics Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *AIP (Am. Inst. Phys.) Conf. Proc.;* **54**: No. 1, 318-331(15 Jul 1979). (CONF-790347—).

From 2. international conference on meson-nuclear physics; Houston, TX, USA (5 Mar 1979).

The features of elastic electron-deuteron scattering for $Q<$ or $=q^2<200$ fm^{-2} are reviewed. The complete set of three observables, electric and magnetic scattering and tensor polarization is examined. The contribution of a variety of relativistic and meson exchange current corrections (including isobar terms) is considered in conjunction with the impulse approximation from several nucleon force models. A phenomenological way of handling unknown, short range meson exchange current effects is described. It is shown that with the meager data presently available there is some information about which nucleon forces may be consistent over a range of q^2 and what the meson exchange current corrections are that go with such models. Experiments which are most likely to give information on models and meson exchange currents are discussed for several ranges of q^2.

3787 Kaon interactions with very light nuclei. Gibson, B.F. (Theoretical Division, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *AIP (Am. Inst. Phys.) Conf. Proc.;* **54**: No. 1, 691-702(15 Jul 1979). (CONF-790347—).

From 2. international conference on meson-nuclear physics; Houston, TX, USA (5 Mar 1979).

Low energy kaon interactions (both K and K) with very light nuclei are reviewed. Limitations upon present K-nucleus studies due to uncertainties in the K-N amplitudes are emphasized along with promising uses. A brief review of some of the many interesting aspects of K-nucleus scattering is given. Comparison of the limited K-d and K-^{4}He elastic data with theory is made. The Kd→πAp reaction is discussed including the possible ΣN virtual bound state.

NUCLEAR PROPERTIES AND REACTIONS, A=1-5, EXPERIMENTAL

NUCLEAR REACTIONS AND SCATTERING

3788 (UCRL—83005) **Neutron cross sections for fusion.** Haight, R.C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Oct 1979. Contract W-7405-ENG-48. 12p. (CONF-791058—1). Dep. NTIS, PC A02/MF A01.

From International conference on nuclear cross sections for technology; Knoxville, TN, USA (22 Oct 1979).

First generation fusion reactors will most likely be based on the ^{3}H(d,n)^{4}He reaction, which produces 14-MeV neutrons. In these reactors, both the number of neutrons and the average neutron energy will be significantly higher than for fission reactors of the same power. Accurate neutron cross section data are therefore of great importance. They are needed in present conceptual designs to calculate neutron transport, energy deposition, nuclear transmutation including tritium breeding and activation, and radiation damage. They are also needed for the interpretation of radiation damage experiments, some of which use neutrons up to 40 MeV. In addition, certain diagnostic measurements of plasma experiments require nuclear cross sections. The quality of currently available data for these applications will be reviewed and current experimental programs will be outlined. The utility of nuclear models to provide these data also will be discussed. 65 references.

NUCLEAR PROPERTIES AND REACTIONS, A=6-19 THEORETICAL

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 3790

NUCLEAR REACTIONS AND SCATTERING

3789 Proton-nucleus total cross sections in the intermediate energy range. Ray, L. (Theoretical Division, Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87545). *Phys. Rev., C;* **20**: No. 5, 1857-1872(Nov 1979).

Proton-nucleus total and reaction cross sections are computed for a number of target nuclei at energies ranging from 100 to 2200 MeV using the Kerman, McManus, and Thaler optical potential formalism and the impulse approximation. Corrections due to Pauli, short-range dynamical, and center-of-mass correlations are included in the calculations. In addition, the electric form factor of the neutron and the nucleon magnetic moments are included in deriving the necessary proton densities from available empirical charge distributions. The proton-nucleon scattering amplitudes are obtained from phase shift solutions or directly from the published N-N data. The proton and neutron point densities are deduced where possible from analyses of electron and proton scattering or from Hartree-Fock predictions if the appropriate elastic angular distribution data are unavailable. An estimate of the uncertainty in the calculated total cross sections is given. The total and reaction cross sections computed in this way are shown to be in very good agreement with the data above 400 MeV but overestimate the data by 15-25% at lower energies, indicating that the approximate multiple scattering calculations generally performed near 1 GeV are inadequate when applied at energies below 400 MeV. Several theoretical improvements are suggested for this lower energy range and some numerical estimates are given. Analysis of total cross section data is also shown to be an unsuitable method for obtaining accurate measurements of neutron matter densities.

3790 ^{12}C(γ,π$^-$)^{12}N/sub g.s./ from threshold to resonance. Epstein, G.N.; Singham, M.K.; Tabakin, F. (Center for Theoretical Physics, Laboratory for Nuclear Science, MIT, Cambridge, Massachusetts 02139). *AIP (Am. Inst. Phys.) Conf. Proc.;* **54**: No. 1, 432-433(15 Jul 1979). (CONF-790347—).

From 2. international conference o 5meson-nuclear physics; Houston, TX, USA (5 Mar 1979).

We calculate both total and differential cross-sections for the reaction
ranging from 0—180 MeV. We pay particular attention to the role of non-static terms in the photoproduction operator.

3791 Overview of π-nucleus scattering. Eisenstein, R.A. (Carnegie-Mellon University, Pittsburgh, Pennsylvania 15213). *AIP (Am. Inst. Phys.) Conf. Proc.;* **54**: No. 1, 440-454(15 Jul 1979). (CONF-790347—).

From 2. international conference on meson-nuclear physics; Houston, TX, USA (5 Mar 1979).

A concise examination of the π-nucleus elastic and inelastic scattering problem is made. A brief discussion of some of the ambiguities in current interpretations of the data is presented. The influence of such ambiguities on nuclear matter density determinations and other topics of nuclear structure interest is examined. Such uncertainties may be more harmful to elastic than inelastic scattering analysis.

3792 Threshold pion electroproduction and the nuclear response surface. Haxton, W.C. (Los Alamos Scientific Lab., NM (USA)). *Nucl. Phys., A;* **306**: No. 3, 429-446(28 Aug 1978).

Information gained from inelastic electron scattering is used as a guide to the treatment of the nuclear response surface probed in pion electroproduction near threshold. A comparison of theory with the Mainz data is made. (Auth.)end.

NUCLEAR PROPERTIES AND REACTIONS, A=6-19, EXPERIMENTAL

RADIOACTIVE DECAY

REFER ALSO TO CITATION(S) 3796

3793 Beta decay of ^{15}C. Alburger, D.E.; Millener, D.J. (Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev., C;* **20**: No. 5, 1891-1901(Nov 1979).

The spectrum of γ rays following the β decay of ^{15}C, produced in the ^{13}C(t,p)^{15}C reaction, has been studied with a 50-cm^3 Ge(Li) detector. Allowed β-ray branches to all available ^{15}N excited states known to have J/sup π/ = 1/2$^+$ or 3/2$^+$ were measured including a branch to the 8571-keV state not reported previously. A value of 2.449 +- 0.005 sec was obtained for the ^{15}C half-life by multiscaling β rays detected in a plastic scintillator. The experimental ^{15}C β-ray transition rates are compared with theoretical calculations.

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 3793, 3794, 3799, 3800, 3801

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 3793, 3822, 3839

3794 Evidence for the isovector giant quadrupole resonance in ^{16}O from the ^{16}O(γ,n$_0$)^{15}O reaction. Phillips, T.W.; Johnson, R.G. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). *Phys. Rev., C;* **20**: No. 5, 1689-1699(Nov 1979).

The cross section and angular distribution for the reaction ^{16}O(γ,n$_0$)^{15}O have been measured over an excitation energy range of 25— 45 MeV. Neutron time-of-flight spectra were recorded at six angles (22.5°, 45°, 67.5°, 90°, 112.5°, and 135°) and at four brems-

strahlung end-point energies (30, 35, 40, and 45 MeV). Differential cross sections deduced from these spectra were fitted by a fourth-order Legendre-polynomial expansion. The cross section obtained from this expansion decreases smoothly from 3.95 mb at 25.5 MeV to 0.22 mb at 43.8 MeV. The appearance in this analysis of large first-, third-, and especially fourth-order coefficients, is strong evidence for significant E2 cross section. An E2 cross section extracted from the data exhausts approximately 68% of the isovector E2 energy-weighted sum rule. The present data are compared to previous related measurements and excellent agreement is seen. In comparisons with theoretical studies on ^{16}O, there is good general agreement but relatively poor detailed agreement.

3795 Fine structure in the elastic and inelastic scattering of $^{12}C + ^{28}Si$ and $^{16}O + ^{28}Si$. Barrette, J.; LeVine, M.J.; Braun-Munzinger, P.; Berkowitz, G.M.; Gai, M.; Harris, J.W.; Jachcinski, C.M.; Uhlhorn, C.D. (Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev., C;* **20**: No. 5, 1759-1767(Nov 1979).

The θ/sub c.m./ = 180° elastic and inelastic excitation functions have been measured for the systems $^{12}C + ^{28}Si$ (27.8 < or = E/sub c.m./ < or = 31.5 MeV) and $^{16}O + ^{28}Si$ (30.0 < or = E/sub c.m./ < or = 32.7 MeV) in small steps (δE/sub c.m./ < 100 keV). In both systems it is observed that the gross structures previously found ($\Gamma \cong$ 1—2 MeV) are strongly split into finer structure. A statistical analysis of the data has been made to determine the average width, strength, and cross correlation of these narrow structures. The results are compared to the predictions of Hauser-Feshbach calculations. It is concluded that it is impossible within the standard statistical model to simultaneously reproduce both the observed widths and the average fluctuating cross sections.

3796 Absolute cross sections for the $^{12}C(\pi^{+-},\pi N)^{11}C$ reactions between 40 and 600 MeV. Dropesky, B.J.; Butler, G.W.; Orth, C.J.; Williams, R.A.; Yates-Williams, M.A.; Friedlander, G.; Kaufman, S.B. (Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87545). *Phys. Rev., C;* **20**: No. 5, 1844-1856(Nov 1979).

The excitation functions for the $^{12}C(\pi^{+-},\pi N)^{11}C$ reactions have been established for 40- to 600-MeV π^- and 50- to 520-MeV π^+. These excitation functions are dominated by the (3,3) pion-nucleon resonance but show an upward energy shift in the resonance peak for π^- (to about 190 MeV) and a downward shift for π^+ (to about 160 MeV). The $\sigma(\pi^-)/\sigma(\pi^+)$ ratio at 180 MeV is 1.59 +- 0.07. The results are compared with theoretical calculations based on a semiclassical transport model including nucleon charge exchange and an intranuclear cascade model.

3797 Positive pion-nucleus elastic scattering at 40 MeV. Blecher, M.; Gotow, K.; Jenkins, D.; Milder, F.; Bertrand, F.E.; Cleary, T.P.; Gross, E.E.; Ludemann, C.A.; Moinester, M.A.; Burman, R.L.; Hamm, M.; Redwine, R.P.; Yates-Williams, M.; Dam, S.; Darden, C.W. III; Edge, R.D.; Malbrough, D.J.; Marks, T.; Preedom, B.M. (Virginia Polytechnic Institute and State University, Blacksburg, Virginia 24061). *Phys. Rev., C;* **20**: No. 5, 1884-1890(Nov 1979).

Differential cross sections for elastic scattering of 40 MeV positive pions from ^{12}C, ^{16}O, ^{40}Ca, ^{90}Zr, and ^{208}Pb were measured at 18 angles in the angular range 25°—160°. Relative uncertainties of 2.5% to 7% and overall normalization uncertainties of 4% to 7% were obtained. An optical potential fit of the data indicates that while the magnitudes of the strength parameters, except for Re b_1, are different from values obtained from free πN scattering amplitudes, the variation of these magnitudes with target mass is roughly as predicted by the impulse approximation. Coulomb effects, especially in the cases of ^{90}Zr and ^{208}Pb, are extremely important, but impossible to unambiguously separate from the strong interaction in the optical model.

3798 Pion double charge exchange reactions in ^{12}C and /sup 40,44,48/Ca. Davis, J.; Kaellne, J.; McCarthy, J.S.; Minehart, R.C.; Morris, C.L.; Thiessen, H.A.; Blanpied, G.; Burleson, G.R.; Boyer, K.; Cottingame, W.; Moore, C.F.; Goulding, C.A. (University of Virginia, Charlottesville, Virginia 22901). *Phys. Rev., C;* **20**: No. 5, 1946-1948(Nov 1979).

Cross sections, $d^2\sigma/d\Omega dT$, on ^{12}C, /sup 40,44,48/Ca are presented for inclusive (π^+,π^-) and (π^-,π^+) reactions at an incident energy of T/sub π/=290 MeV with the exit pions detected over an energy range of T/sub π/=175—255 MeV at an angle of 60°. These cross sections are found to vary systematically with reported proton-neutron differences in nuclear radial distributions.

3799 Measuring isospin mixing in nuclei using π^{+-} inelastic scattering. Cottingame, W.B.; Braithwaite, W.J.; Morris, C.L. (University of Texas at Austin, Austin, Texas 78712). *AIP (Am. Inst. Phys.) Conf. Proc.;* **54**: No. 1, 272-273(15 Jul 1979). (CONF-790347—).

From 2. international conference on meson-nuclear physics; Houston, TX, USA (5 Mar 1979).

A new strongly isospin-mixed doublet has been found in ^{12}C near 19.5 MeV. in a comparison of π^- and π^+ inelastic scattering at 180 MeV, The present techniques may be universally employable, at least in self-conjugate nuclei, in extracting isospin-mixing matrix elements.

3800 Role of the Δ (1232) isobar in the $^{16}O(\gamma,p)$ process. Leitch, M.J.; Matthews, J.L.; Ingham, D.; Sapp, W.W.; Sargent, C.P.; Findlay, D.J.S.; Owens, R.O.; Roberts, B.L. (Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *AIP (Am. Inst. Phys.) Conf. Proc.;* **54**: No. 1, 357-358(15 Jul 1979). (CONF-790347—).

From 2. international conference on meson-nuclear physics; Houston, TX, USA (5 Mar 1979).

A recent measurement of $^{16}O(\gamma,p_0)$ cross sections for E/sub γ/> or =100 MeV is compared with two theoretical calculations which involve the excitation of the Δ (1232) isobar in an intermediate state.

3801 (K,π) reaction at Brookhaven. May, M. (Brookhaven National Laboratory, Upton, New York 11973). *AIP (Am. Inst. Phys.) Conf. Proc.;* **54**: No. 1, 658-665(15 Jul 1979). (CONF-790347—).

From 2. international conference on meson-nuclear physics; Houston, TX, USA (5 Mar 1979).

The strangeness exchange reaction (K^-,π^-) has been used to study the spectrum of ^{12}C. The angular distributions of the ground state and the peak at 11/sup Λ/ MeV excitation have been measured. Evidence is found for the excitence of two components of the 11 MeV peak. Results of a search for bound states of the Σ^- neutron system are discussed.

NUCLEAR PROPERTIES AND REACTIONS, A=20-38, EXPERIMENTAL

REFER ALSO TO CITATION(S) 3789

RADIOACTIVE DECAY

3802 (LBL—9718) Development of the helium-jet fed on-line mass separator RAMA and its application to studies of T/sub z/ = -2 nuclei. Moltz, D.M. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Oct 1979. Contract W-7405-ENG-48. 131p. Dep. NTIS, PC A07/MF A01.

Thesis.

The study of nuclei far from beta stability is hampered greatly when the nuclide of interest decays in a manner identical to that of a nuclide produced in greater yield in the same bombardment. Attempts to observe the protons associated with the decay of the A = 4n, T/sub z/ = -2 series of beta-delayed proton emitters failed because of the large number of protons arising from the strong beta-delayed proton decay of the A = 4n + 1, T/sub z/ = -3/2 nuclides. One solution to this problem is through the use of an on-line mass separator. Development of the Berkelely helium-jet fed on-line mass separator RAMA is discussed as applied to studies of the A = 4n, T/sub z/ = -2 nuclides. RAMA (Recoil Atom Mass Analyzer) has typical efficiencies of 0.1% for ~ 75 elements with melting points ≦ 2000°C. This efficiency permits decay studies to be readily performed on nuclei with production cross sections ≧ 500 μb for γ-ray spectroscopy and ≦ 1 μb for discrete energy charged particle spectroscopy. The mass range on the normalized RAMA focal plane is +- 10%. The quoted efficiency is for a mass resolution of M/ΔM ~ 300. RAMA has been used to observe two members of the A = 4n, T/sub z/ = -2 series of beta-delayed proton emitters, ^{20}Mg and ^{24}Si. Observation of beta-delayed protons from a mass-separated sample of ^{20}Mg(t/sub 1/2/ ~ 95 ms) establishes the mass-excess of the lowest T = 2 (0^+) state in ^{20}Na (13.42 +- .05 MeV), thereby completing the mass twenty isospin quintet. A similar measurement of the decay of ^{24}Si (t/sub 1/2/ ~ 100 ms) establishes the mass-excess of the lowest T = 2 (0^+) state in ^{24}Al (5.903 +- 0.009 MeV). The mass 24 isospin quintet is incomplete because the mass of ^{24}Si remains unknown. In both cases, excellent agreement is obtained using only the quadratic form of the isobaric multiplet mass equation (IMME). 79 references.

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 3802

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 3839

3803 Energetic charged-particle spectrum following μ^- capture by nuclei. Krane, K.S.; Sharma, T.C.; Swenson, L.W.; McDaniels, D.K.; Varghese, P.; Wood, B.E.; Silbar, R.R.; Wohlfahrt, H.D.;

Goulding, C.A. (Department of Physics, Oregon State University, Corvallis, Oregon 97331). *Phys. Rev., C;* **20**: No. 5, 1873-1877(Nov 1979).

The energy spectra of charged particles (mainly protons) emitted following muon capture have been measured for targets of Al, Cu, and Pb. The intensity of the energetic (40 —70 MeV) emitted particles falls exponentially with increasing energy, $I=I_0\exp(-E/E_0)$, with exponential constant E_0 7.5 +- 0.4 MeV (Al), 8.3 +- 0.5 MeV (Cu), 9.9 +- 1.1 MeV (Pb). The integrated yield for particles above 40 MeV was found to be (1.38 +- 0.09) x 10^{-3} per capture for Al, (1.96 +- 0.12) x 10^{-3} per capture for Cu, and (0.171 +- 0.028) x 10^{-3} per capture for Pb.

3804 Evidence that for non absorption reactions of 190-MeV π^+ π^- on ^{27}Al multinuclear removal often occurs as separate particles. McAdams, R.E.; Otteson, O.H.; Lind, V.G.; Denig, W.F.; Goulding, C.A.; Greenfield, M.; Plendl, H.S.; Lieb, B.J.; Stronach, C.E.; Gram, P.A.M.; Sharma, T. (Utah State University, Logan, Utaha 84322). *AIP (Am. Inst. Phys.) Conf. Proc.;* **54**: No. 1, 178-179(15 Jul 1979). (CONF-790347—).

From 2. international conference on meson-nuclear physics; Houston, TX, USA (5 Mar 1979).

Gamma-ray spectra in coincidence with scattered pions at 35° were obtained for π^+ and π^- incident on ^{27}Al at LAMPF. The gamma-ray spectra in coincidence with the scattered π^+ or π^- were separated into two energy bins each: E/sub π/' < 80 MeV and E/sub π/' > 80 MeV. The average ratio of the differential cross section for the high-energy bin to the low-energy bin is 2.0 +- 0.2 for single particle removal and 1.3 +- 0.02 for multiparticle removal indicating that, in addition to possible cluster removal, the particles are removed as separate particles for a significant portion of the time.

3805 Quasi-free single nucleon removal in pi-nuclear scattering. Otteson, O.H.; McAdams, R.E.; Lind, V.G.; Denig, W.F.; Goulding, C.A.; Greenfield, M.; Plendl, H.S.; Lieb, B.J.; Stronach, C.E.; Gram, P.A.M.; Sharma, T. (Utah State University, Logan, Utah 84322). *AIP (Am. Inst. Phys.) Conf. Proc.;* **54**: No. 1, 282-283(15 Jul 1979). (CONF-790347—).

From 2. international conference on meson-nuclear physics; Houston, TX, USA (5 Mar 1979).

Proton and pion spectra obtained in coincidence with the prompt gamma rays following the bombardment of ^{27}Al by 190-MeV pions provides evidence for quasi-free single nucleon removal. The single nucleon removal ratios are not in agreement with a single quasi-free scattering model. However, the proton distributions in coincidence with the respective gamma rays are in good agreement. The angular distributions are also in substantial agreement with a quasi-free scattering mechanism.

NUCLEAR PROPERTIES AND REACTIONS, A=39-58, EXPERIMENTAL

REFER ALSO TO CITATION(S) 3789

ENERGY LEVELS AND TRANSITIONS

3806 (UCRL—82998) **New parameterization of the E1 gamma-ray strength function.** Gardner, D.G.; Dietrich, F.S. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 18 Oct 1979. Contract W-7405-ENG-48. 7p. (CONF-791058—3). Dep. NTIS, PC A02/MF A01.

From International conference on nuclear cross sections for technology; Knoxville, TN, USA (22 Oct 1979).

The giant dipole (GD) parameters of peak energy, width, and cross section were satisfactorily correlated for elements from V to Bi, assuming two overlapping peaks with a separation dependent on deformation. The energy dependence of the GD resonance is assumed to have a Breit-Wigner form, but with an energy-dependent width. The resulting gamma-ray strength function model is used to predict neutron capture cross sections and gamma-ray spectra for isotopes of Ta, Os, and Au. 23 references.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 3797, 3798, 3822, 3826

3807 Fast-neutron total and scattering cross sections of elemental titanium. Smith, A.; Guenther, P.; Moldauer, P.; Whalen, J. (Argonne National Lab., IL (USA)). *Nucl. Phys., A;* **307**: No. 2, 224-238(11 Sep 1978).

Energy-averaged total neutron cross sections of elemental titanium are measured from approximately 1.0 to 4.5 MeV with statistical accuracies of approximately 1%. Differential elastic neutron-scattering angular distributions are measured from 1.5 to 4.0 MeV at incident energy intervals of < = 0.2 MeV. Differential cross sections for the inelastic neutron excitation of 'states' in titanium at 158 +- 26, 891 +- 8, 984 +- 15, 1428 +- 39, 1541 +- 30, 1670 +- 80, 2007 +- 8, 2304 +- 22, 2424 +- 16 and 2615 +- 10 keV are measured in the incident-neutron energy range 1.5 to 4.0 MeV. Neutrons corresponding to additional states at approximately 2845 and 3010 keV were qualitatively observed. The experimental results are interpreted in terms of an energy-averaged optical-statistical and coupled-channels models including consideration of collective vibrations. The implications of these models and their use in the context of strong fluctuating structure are discussed.

NUCLEAR PROPERTIES AND REACTIONS, A=59-89, EXPERIMENTAL

REFER ALSO TO CITATION(S) 3789

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 3806

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 3803, 3826

3808 (CONF-790743—7) **Observation of a random component of transferred angular momentum in the reaction ^{20}Ne + ^{63}Cu: application of a Monte-Carlo method for the deduction of primary-fragment characteristics in deep inelastic collisions.** Gomez del Campo, J. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 24p. Dep. NTIS, PC A02/MF A01.

From Symposium on heavy ion physics from 10-200 MeV/A; Upton, NY, USA (16 Jul 1979).

A general problem in the study of heavy-ion reactions is the deduction of the properties of the primary stage of a nuclear collision from the remnants produced by the decay of the excited fragments. A Monte-Carlo statistical model is applied for the decay of equilibrated fragments to the analysis of the secondary products from the deep inelastic collision of 168 MeV ^{20}Ne with ^{63}Cu. The width of the energy spread of the primary fragments is found to be a factor of two smaller than the laboratory spread. A preliminary analysis of the in-plane and out-of-plane α particle angular distributions suggests the presence of a nonequilibrium component in the α particle emission and a randomly oriented component in the transferred angular momentum. The predictions of recent models for the introduction of a random component of angular momentum in deep inelastic collisions are compared with the results from analysis of γ-ray emission in the reaction of ^{20}Ne + ^{63}Cu. 14 references.

NUCLEAR PROPERTIES AND REACTIONS, A=90-149, EXPERIMENTAL

3809 (LBL—9283) **Relativistic heavy ion physics.** Westfall, G.D. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jun 1979. Contract W-7405-ENG-48. 5p. (CONF-7905110—1). Dep. NTIS, PC A02/MF A01.

From Workshop on the future directions of nuclear physics; Boulder, CO, USA (29 May 1979).

The main objective of the study of nuclear physics is pointed out to be the study of nuclear properties under conditions far from normal nuclear densities and excitations. Another objective in relativistic heavy ion physics is to study conventional nuclear properties such as the limits of nuclear stability, ground state correlations, and the excitation of high multipole giant resources. Exotic phenomena, inclusive interactions, reaction mechanisms, and the types of experimental facilities and planning are briefly noted. 15 references. (JFP)

RADIOACTIVE DECAY

REFER ALSO TO CITATION(S) 3813

3810 (CONF-790968—3) **Alpha-decay systematics for elements with 50 < Z < 83.** Toth, K.S. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 10p. Dep. NTIS, PC A02/MF A01.

From 6. international conference on atomic masses; East Lansing, MI, USA (18 Sep 1979).

Recent data reported on α-emitting isotopes in the mass region above 140 are reviewed, α-decay energies are compared with predictions of mass formulae, and α-decay rates of even-even nuclei are discussed. 19 references.

3811 (ORNL/TM—7058) **Recent capture cross section data from ORELA above 2.6 keV.** Macklin, R.L.; Winters, R.R.; Halperin,

J. (Oak Ridge National Lab., TN (USA)). Oct 1979. Contract W-7405-ENG-26. 17p. Dep. NTIS, PC A02/MF A01.

Neutron capture by natural rhodium (^{103}Rh) and enriched stable isotopes of ruthenium (100 to 104) and palladium (104 to 110) were measured at the Oak Ridge Electron Linear Accelerator pulsed neutron facility. Average pure isotope cross sections from three to several hundred keV were derived. The neutron flux shape was determined relative to ENDF/B V standard ^{6}Li(n,α) and ^{235}U(n,f) cross sections below and above 70 keV respectively. Strength functions were adjusted to fit the data by least squares. The ^{101}Ru fission product would appear to cause less poisoning than ^{105}Pd or ^{103}Rh in plutonium fueled fast reactors. 7 references.

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 3806, 3815

3812 (UCRL—83319) **Properties of neutron-rich nuclei studied by fission product nuclear chemistry.** Meyer, R.A.; Henry, E.A.; Griffin, H.C.; Lien, O.G. III; Lane, S.M.; Stevenson, P.C.; Yaffe, R.P.; Skarnemark, G. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Sep 1979. Contract W-7405-ENG-48. 24p. (CONF-790976—4). Dep. NTIS, PC A02/MF A01.

From International symposium on future directions in studies of nuclei far from stability; Nashville, TN, USA (10 Sep 1979).

A review is given of the properties of neutron-rich nuclei studied by fission product nuclear chemistry and includes the techniques used in elemental isolation and current research on the structure of nuclei near ^{132}Sn, particle emission, and coexisting structure in both neutron-poor and neutron-rich nuclei. 35 references. (JFP)

3813 **Nuclear data sheets for A=111.** Harmatz, B. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830, USA). *Nucl. Data Sheets;* **27**: No. 3, 453-516(Jul 1979).

Nuclear structure information available to February 1979 has been reviewed. The level properties obtained from decay and reaction experiments are shown in the drawings. Experimental methods, references, and comments are given in the text.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 3843

3814 (ORO—4043-39) **Experiments on the nuclear interactions of pions. Progress report, December 1, 1979-November 30, 1980.** Minehart, R.C.; Ziock, K.O.H. (Virginia Univ., Charlottesville (USA)). 1979. Contract EY-76-S-05-4043. 21p. Dep. NTIS, PC A02/MF A01.

Experimental research on pion reactions is summarized. A list of publications and one of abstracts of given talks are included, as are some abstracts of talks to be given at meetings. (JFP)

3815 **Octupole transitions in the ^{92}Mo(π^{+-},π^{+-})reactions.** Doss, K.G.R.; Eisenstein, R.A.; Wharton, W.R.; Blanpied, G.; Burleson, G.R.; Amann, J.F. (Carnegie-Mellon University, Pittsburgh, Pennsylvania 88003). *AIP (Am. Inst. Phys.) Conf. Proc.;* **54**: No. 1, 533-534(15 Jul 1979). (CONF-790347—).

From 2. international conference on meson-nuclear physics; Houston, TX, USA (5 Mar 1979).

The ^{92}Mo(π^{+-},π^{+-})reactions at T/sub π/=180 MeV populating octupole states are examined to suggest the (π,π') reaction as an interesting probe of nuclear structure.

NUCLEAR PROPERTIES AND REACTIONS, A=150-189, EXPERIMENTAL

RADIOACTIVE DECAY

REFER ALSO TO CITATION(S) 3810

3816 (CONF-790976—2) **Alpha-decay studies in the lead region.** Toth, K.S. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 6p. Dep. NTIS, PC A02/MF A01.

From International symposium on future directions in studies of nuclei far from stability; Nashville, TN, USA (10 Sep 1979).

Alpha particle emission was observed for the new isotopes ^{184} ^{185}Tl as well as for the previously known nuclides ^{186} ^{187}Tl. Also determined were the alpha decay half-lives for lead isotopes with A $\leq$ 192. 8 references. (JFP)

3817 **Decay of ^{172}Hf to levels in ^{172}Lu.** Toth, K.S.; Ellis, Y.A.; Sousa, D.C.; Carter, H.K.; Sen, D.; Zganjar, E.F. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Phys. Rev., C;* **20**: No. 5, 1902-1907(Nov 1979).

The electron-capture decay of ^{172}Hf was investigated. Single and coincidence measurements were made by using germanium x-ray detectors. In addition, a Si(Li) detector was used to study the low-energy portion, $<$ or $\simeq$ 60 keV, of the γ-ray spectrum. These results were then combined with available conversion-electron data which had been obtained with a magnetic spectrometer. From this information, a decay scheme for ^{172}Hf was constructed. It incorporates 17 transitions into 11 excited levels in ^{172}Lu and differs from previously proposed decay schemes. Several transitions previously attributed to ^{172}Hf decay were not observed in the present study. The electron-capture decay energy was deduced from measured K x-ray intensities and the level scheme to be 350 +- 50 keV.

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 3806, 3817

3818 (CONF-790976—3) **Subnanosecond lifetime measurements of excited states in nuclei far from stability.** Nettles, W.G.; Ramayya, A.V.; Hamilton, J.H.; Avignone, F.T. III; Carter, H.K. (Vanderbilt Univ., Nashville, TN (USA); South Carolina Univ., Columbia (USA); Oak Ridge Associated Universities, Inc., TN (USA)). 1979. Contract W-7405-ENG-26. 5p. Dep. NTIS, PC A02/MF A01.

From International symposium on future directions in studies of nuclei far from stability; Nashville, TN, USA (10 Sep 1979).

A system was developed to measure the lifetimes of nuclear states in the range of 0.05 to 1 nanosecond in nuclei far from stability. A Gerholm magnetic lens was placed on-line with the UNISOR mass separator to observe conversion electrons in coincidence with γ rays detected in a plastic scintillator. With this system, the half-life of the 522 keV, O^+ level in ^{186}Hg was measured to be 155 +- 70 picoseconds. Improvements in this system should make possible on-line measurements of half-lives as short as $\simeq$ 50 picoseconds. 12 references.

3819 **Reduced transition probabilities and energies of high-spin states in ^{162}Dy.** Guidry, M.W.; Lee, I.Y.; Johnson, N.R.; Butler, P.A.; Cline, D.; Colombani, P.; Diamond, R.M.; Stephens, F.S. (Department of Physics, University of Tennessee, Knoxville, Tennessee 37916). *Phys. Rev., C;* **20**: No. 5, 1814-1818(Nov 1979).

Multiple Coulomb excitation and Doppler-broadened line-shape analyses have been applied to the nucleus ^{162}Dy, allowing ground-band energies through the 18^+, lifetimes through the 14^+, and reduced transition probabilities through the 18^+ state to be determined. Energy levels show smooth departure from the rotational model with no backbending, while the B (E2) values are consistent with the rotational model through spin 18. Comparison is made to similar results for high spins in other good rotors. The results strengthen our conclusions reached in previous papers: The compression of energy levels observed at high spins in good rotors is largely due to pairing changes, which have only a small effect on transition probabilities.

3820 **Muonic resonance excitation of ^{189}Os and ^{172}Yb.** Hoehn, M.V.; Shera, E.B. (Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87545). *Phys. Rev., C;* **20**: No. 5, 1934-1941(Nov 1979).

"Anomalous" lines of significant intensity have been observed in the muonic spectra of ^{189}Os and ^{172}Yb. These anomalous lines are interpreted as 3d-2p muonic-nuclear resonances involving 1^- and 3^- nuclear states at about 2-MeV excitation energy. Electric multipole moments and isomer shifts of the resonant nuclear states have been determined. Such accidental resonances, which presumably occur in other heavy muonic atoms, can provide an opportunity to obtain otherwise unavailable nuclear structure information.

3821 **Levels in ^{167} ^{169}Ho populated in the (t(pol), α) reaction.** Loevhoeiden, G. (Bergen Univ. (Norway)); Burke, D.G. (McMaster Univ., Hamilton, Ontario (Canada). Tandem Accelerator Lab.); Flynn, E.R.; Sunier, J.W. (Los Alamos Scientific Lab., NM (USA)). *Nucl. Phys., A;* **315**: No. 1, 90-108(1979).

The ^{168} ^{170}Er(t(pol), α)^{167} ^{169}Ho reactions have been studied using 17 MeV tritons with a polarization of 0.78 from the Los Alamos tandem Van de Graaff accelerator facility. The reaction products were momentum analyzed with a Q3D magnetic spectrometer and detected with a helical-cathode position-sensitive proportional counter. The angular distributions for strongly populated levels in general allowed unique determination of spin and parity. As the previous knowledge of the structure of ^{167}Ho and ^{169}Ho was not extensive the present data have contributed significantly to the understanding of these nuclei. The ^{167}Ho results confirm the assignments from decay scheme studies and extend the interpretation to higher energies. In ^{169}Ho the results from the present experiment confirm some assignments from a recent (d, ^{3}He) study and show that others were incorrect. Spectroscopic factors for the strongest transitions are in reasonable agreement with expectations from the Nilsson model with pairing and Coriolis couplings included.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 3806, 3819, 3821

3822 **Inelastic electron scattering.** Bertozzi, W. (Massachusetts Inst. of Tech., Cambridge). Contract EY-76-C-02-3069. pp 231-245 of Nuclear interactions. Robson, B. (ed.). New York; Springer-Verlag (1978).

From Conference on nuclear interactions; Canberra, Australia (28 Aug 1978).

A qualitative introduction to electron scattering is presented. Because of the nature of the electromagnetic interaction, electron scattering can be used to make very accurate determinations of nuclear charge, current, and magnetization densities. The following aspects of the subject are discussed: collective vibrations, high-multipolarity magnetic single-particle transitions, polarization effects in oxygen isotopes, and nuclear deformations (rotational model, dispersive corrections, even-nuclei, odd-even nuclei). In conclusion, the need for detailed and accurate calculations of nuclear models is stressed. 22 figures, 1 table. (RWR)

NUCLEAR PROPERTIES AND REACTIONS, A=190-219, EXPERIMENTAL

RADIOACTIVE DECAY

REFER ALSO TO CITATION(S) 3810, 3816

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 3806

3823 **High-spin states in ^{210}Rn: The effect of the neutron holes on the four-proton configurations.** Poletti, A.R.; Sjoreen, T.P.; Fossan, D.B.; Garg, U.; Neskakis, A.; Warburton, E.K. (Brookhaven National Laboratory and State University of New York at Stony Brook, Stony Brook, New York 11794). *Phys. Rev., C;* **20**: No. 5, 1768-1774(Nov 1979).

High-spin states in ^{210}Rn were observed with the aid of the ^{204}Pb(^{9}Be,3n)^{210}Rn reaction. γ-γ coincidence, excitation function, γ-ray angular distribution, and pulsed beam lifetime measurements were used to construct a decay scheme. Mean lives of four levels were deduced and multipolarities of γ-ray transitions and level spins were inferred.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 3797, 3803, 3822, 3823

3824 **Observations in the reaction of two magic nuclei: ^{208}Pb and ^{48}Ca.** Nitschke, J.M.; Leber, R.E.; Nurmia, M.J.; Ghiorso, A. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). *Nucl. Phys., A;* **313**: No. 1, 236-250(1979).

Excitation functions for compound-nucleus and transfer reactions have been measured with ^{48}Ca ions on ^{208}Pb targets. A comparison is made with the ^{40}Ar-on-^{208}Pb reaction to explain the observed anomalous behavior of the transfer reactions and a surprising cutoff of the (^{48}Ca,3n) exit channel. The former effect is interpreted as an enhancement of the tunneling gap between the projectile and the target, while the latter is seen as a consequence of the angular momentum of the compound nucleus.

NUCLEAR PROPERTIES AND REACTIONS, A=220 AND ABOVE, EXPERIMENTAL

REFER ALSO TO CITATION(S) 3851

RADIOACTIVE DECAY

REFER ALSO TO CITATION(S) 3810

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 3827

3825 **Nuclear levels in ^{238}Np.** Ionescu, V.A.; Kern, J. (Fribourg Univ. (Switzerland). Inst. de Physique); Casten, R.F.; Kane, W.R. (Brookhaven National Lab., Upton, NY (USA)); Ahmad, I.; Erskine, J.; Friedman, A.M.; Katori, K. (Argonne National Lab., IL (USA)). *Nucl. Phys., A;* **313**: No. 3, 283-306(22 Jan 1979).

Low and high energy spectra from thermal neutron capture in ^{237}Np have been studied over the energy ranges 25 to 650 keV and 2600 to 5500 keV. Primary transitions from neutron capture in four resonances have been observed between about 4800 and 5400 keV. Using 12 MeV deuterons (d,p) spectra at three angles have been observed with a magnetic spectrograph. A nuclear level scheme for ^{238}Np has been constructed by combining the results of the above measurements with previous data from a study of the /sup 242m/Am α-decay. The Nilsson model has been used to interpret the level structure. Including results from the previous α-decay study, nine rotational bands can be assigned. The measured (d,p) reaction cross sections are compared with theoretical calculations. The Gallagher-Moszkowski rule is found to be valid in the four cases where both parallel and antiparallel coupled bands have been observed with $K^{+}=\Omega$/sub p/$+\Omega$/sub n/ and $K^{-}=$mod(Ω/sub p/-Ω/sub n/). The lowest levels of the two K=0 bands have spin I=1; Newby odd-even shifts can be determined in both cases.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 3825

3826 (BNL-NCS—26760) **Status of data testing of ENDF/B-V reactor dosimetry file.** Magurno, B.A. (Brookhaven National Lab., Upton, NY (USA)). 1979. Contract EY-76-C-02-0016. 11p. (CONF-791051—3). Dep. NTIS, PC A02/MF A01.

From 3. ASTM-EURATOM symposium on reactor dosimetry; Ispra, Italy (1 Oct 1979).

The ENDF/B-V Reactor Dosimetry File was released August 1979, and Phase II data testing started. The results presented here are from Brookhaven National Laboratory only, and are considered preliminary. The tests include calculated spectrum-averaged cross sections using ^{235}U fission spectrum (Watt), ^{252}Cf spontaneous fission spectrum (Watt and Maxwellian), and the Coupled Fast Reactor Measurement Facility (CFRMF) spectrum. 6 tables.

3827 (LA—7853-MS) **Thermal-neutron capture-gamma spectrum of ^{242}Pu.** Bendt, P.J.; Jurney, E.T. (Los Alamos Scientific Lab., NM (USA)). May 1979. Contract W-7405-ENG-36. 19p. Dep. NTIS, PC A02/MF A01.

The (n,γ) spectrum from a sample of ^{242}Pu irradiated in the thermal column of the Omega West Reactor was observed from 100 to 5200 keV with both Ge(Li) and NaI(Tl) detectors. The energies and partial cross sections were determined for 407 gamma lines, using the Ge(Li) detector. The continuous spectrum observed with NaI(Tl) is displayed in 20 keV energy bins. Summing over the NaI(Tl) spectrum, an (n,γ) cross section equal to 18.5 +- 1 barns was obtained, and also a multiplicity of 4.5 +- 0.2 photons per captured neutron. 9 references.

3828 **Evaluation of the ^{238}U neutron cross-sections for incident neutron energies up to 4 keV.** De Saussure, G.; Olsen, D.K.; Perez, R.B.; Difilippo, F.C (Oak Ridge National Lab., TN (USA)). *Prog. Nucl. Energy;* **3**: No. 2, 87-124(1979).

An evaluation is described of the ^{238}U cross-sections below 4 keV. Recent measurements and re-analyses of older data are discussed. Evaluated resonance parameters are obtained for 164 s-wave levels. The capture widths of the first three s-wave levels are significantly lower than in the ENDF/B-IV evaluation. The s-wave strength function above 1.5 keV is systematically larger than in ENDF/B-IV. Statistical and systematic uncertainties are evaluated for the resonance parameters and for the smooth backgrounds. The statistical distributions of the resonance parameters are compared with theoretically expected distributions.

SPONTANEOUS AND INDUCED FISSION

3829 (BNL—26805) **Analysis of neutron yield produced by high energy proton.** Takahashi, H.; Nakanara, Y. (Brookhaven National Lab., Upton, NY (USA)). 1979. Contract EY-76-C-02-0016. 5p. (CONF-791058—4). Dep. NTIS MF A01.

From International conference on nuclear cross sections for technology; Knoxville, TN, USA (22 Oct 1979).

Portions of document are illegible.

Vasil'kov et al.'s experiments for neutron yield and neutron capture distribution produced by 400 and 660 MeV protons were analyzed by using ENDF/B-IV data and the BNL codes NMTC and TWOTRAN. The calculated total neutron radiative capture by ^{238}U is 77 and 60% of the measured values for protons of 660 and 400 MeV, respectively. The calculated distribution has the higher peak in the central part of the target system, and steeper gradient both in the r and z directions, compared to experimental. The leakage rate of neutrons from the target assembly is calculated as more than 20%, which is much higher than the 10% estimated from the experiment. The total neutron captures determined using ENDF/B-IV are 3.8 and 3.0% higher than those determined using ENDF/B-III for protons of 660 and 400 MeV, respectively. 12 references.

3830 (LA-UR—79-2890) **Delayed neutron calculations using ENDF/B-V data.** England, T.R.; Shenter, R.E.; Schmittroth, F. (Los

Alamos Scientific Lab., NM (USA); Hanford Engineering Development Lab., Richland, WA (USA)). 1979. Contract W-7405-ENG-36. 5p. (CONF-791058—11). Dep. NTIS, PC A02/MF A01.

From International conference on nuclear cross sections for technology; Knoxville, TN, USA (22 Oct 1979).

Data from 20 fission yield sets in ENDF/B-V are used with the emission probabilities (Pn) of 105 delayed neutron precursors to calculate 6-group and total equilibrium delayed neutron yields of (anti ν/sub d/). Results are compared with recent evaluations and selected measurements of anti ν/sub d/. Least-squares data adjustment methods are in progress to improve agreement; preliminary results indicate significant improvement when fission yields are adjusted. 2 tables.

3831 Excitation energy dependence of the total kinetic energy release in the ^{241}Pu(^{3}He,αf) reaction. Back, B.B.; Lebowitz, J.M.; Wolf, K.L. (Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev., C;* **20**: No. 5, 1819-1823(Nov 1979).

Total fission kinetic energies E/sub K/ have been measured as a function of excitation energy in the ^{240}Pu nucleus excited in the ^{241}Pu(^{3}He,α) reaction. A small negative slope of dE/sub K//dE* $\approx$ -0.05 is observed in the excitation energy region E*=5—9 MeV. This is substantially smaller than the slope of dE/sub K//dE*=-1.1 observed in the ^{240}Pu(α,α'f) reaction and slightly smaller than the slope of dE/sub K//dE* $\approx$ -0.35 obtained from (d,pf) and neutron capture reactions. It is concluded that the primary reaction mechanism plays a decisive role for the total kinetic energy release at near barrier energies but that the angular momentum transfer is not the important parameter. The data are discussed in terms of a simple scission-point model, and in particular the effect of the Z=50, N=82 spherical doubly magic shell in the nascent fragments.

3832 Fission of ^{241}Am with 14.8-MeV neutrons. Prindle, A.L.; Sisson, D.H.; Nethaway, D.R.; Kantelo, M.V.; Sigg, R.A. (University of California, Lawrence Livermore Laboratory, Livermore, California 94550). *Phys. Rev., C;* **20**: No. 5, 1824-1830(Nov 1979).

We have measured the mass-yield distribution from fission of ^{241}Am induced by 14.8-MeV neutrons. Yields were measured for 57 fission products from ^{86}Rb to ^{161}Tb. Data for 38 total chain yields were used to construct the mass-yield curve. Absolute fission yields were obtained with an accuracy of about 4% by the requirement of unit total yield in each half of the mass-yield distribution. Absolute yields were also obtained by means of the ^{238}U(n, f) monitor reaction, but the results from the two methods are not in agreement. The disagreement may be due to uncertainty in the ^{241}Am fission cross section; from our data we infer a cross section of 2.32 +- 0.09 b at 14.8 MeV. The peak-to-valley ratio in the mass-yield distribution is about 3.4. Several independent and cumulative fractional chain yields were measured, and Z/sub p/ values inferred from these measurements are in good agreement with those estimated from independent-yield systematics. Several partial isomer yields and isomer ratios were measured.

3833 Fissionability of nuclides in the thorium region at excitation energies to 100 MeV. Hogan, J.J.; Gadioli, E.; Gadioli-Erba, E.; Chung, C. (Department of Chemistry, McGill University, Montreal, Quebec, Canada). *Phys. Rev., C;* **20**: No. 5, 1831-1843(Nov 1979).

We have measured seven and compiled from the literature seventeen excitation functions for spallation residues from the interaction of 10 —100 MeV protons on ^{232}Th. Calculations of these excitation functions have been made using the theoretical framework of the pre-equilibrium exciton model of nuclear reactions to which has been added a fission option. The fit of the theory to the experimental data is excellent, lending confidence to our treatment of the competition between fission and particle emission. After showing and discussing the comparison of the calculated and experimental results, we present representative graphs of the variations in fissionability with Z^2/A and with the excitation energy.

NUCLEAR THEORY

NUCLEAR STRUCTURE

REFER ALSO TO CITATION(S) 3791

3834 (UCRL—83462) **Limits of thermodynamic models for nuclear level densities.** Grimes, S.M. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Sep 1979. Contract W-7405-ENG-48. 26p. (CONF-790959—2). Dep. NTIS, PC A03/MF A01.

From Conference on theory and applications of moment methods in many fermion systems; Iowa City, IA, USA (10 Sep 1979).

The current status of thermodynamic models as applied to nuclear level densities is reviewed. Considerable refinement has taken place during the last fifteen years, with the result that some of the undesirable assumptions originally required by the model are no longer necessary. Some problems remain, however, particularly in calculating level densities for deformed nuclei. Furthermore, some related parameters, such as the positive-parity negative-parity ratio for levels and the spin cutoff parameter are more sensitive to the presence of two-body interactions than the total level density. Improvement in characterization of nuclear level densities will require use of techniques which can incorporate the effects of two-body interactions in the level density calculation. 25 references.

3835 Very high-spin states. Stephens, F.S. (Univ. of California, Berkeley). pp 117-124 of Nuclear interactions. Robson, B. (ed.). New York; Springer-Verlag (1978).

From Conference on nuclear interactions; Canberra, Australia (28 Aug 1978).

Recent progress in the study of high-spin states is reviewed. Ideas about very high-spin states are based on two types of considerations - macroscopic and microscopic. The types of behavior of very high-spin states are described, and examples of that behavior are discussed. Collective effects in nuclear structure are addressed. 16 figures. (RWR)

NUCLEAR MATTER

REFER ALSO TO CITATION(S) 3791, 3842

3836 (ORO—3992-361) **Shock waves in relativistic nuclear matter, I.** Gleeson, A.M.; Raha, S. (Texas Univ., Austin (USA). Center for Particle Theory). Feb 1979. Contract EY-76-S-05-3992. 52p. Dep. NTIS, PC A04/MF A01.

The relativistic Rankine-Hugoniot relations are developed for a 3-dimensional plane shock and a 3-dimensional oblique shock. Using these discontinuity relations together with various equations of state for nuclear matter, the temperatures and the compressibilities attainable by shock compression for a wide range of laboratory kinetic energy of the projectile are calculated. 12 references.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 3753, 3763, 3766

3837 (COO—2171-198) **Nuclear structure theory. Annual technical progress report, October 1, 1978-September 30, 1979.** French, J.B.; Koltun, D.S. (Rochester Univ., NY (USA)). 1979. Contract EY-76-S-02-2171. 10p. Dep. NTIS, PC A02/MF A01.

This report summarizes progress during the past year in the following areas of nuclear structure and reaction theory: Statistical spectroscopy, including: Random matrix methods, with applications to fluctuations in spectra and in strength distributions, and to problems of ergodicity; Group symmetries in spectral-distribution theory; Electromagnetic and β transitions. Meson scattering and absorption by nuclei, including: general scattering theory with absorption, multiple scattering theory and its reactive content, statistical theory of absorption, theory of the absorption operator (πNN vertex), theory of πN scattering. A list of publications is included.

3838 180° production of p, d, and t, and p-p correlation in p-nucleus collisions. Ko, C.; Ta-chung, M. (Nuclear Science Division, Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *Phys. Rev. Lett.;* **43**: No. 14, 994-997(1 Oct 1979).

The characteristic features of the energy distributions of the 180°-emitted protons, deuterons, and tritons from 0.6 to 400 GeV incident energy, the extremely weak angular dependence of single-particle inclusive cross sections in the backward directions, and the existence of forward-backward pp correlation are shown to be due to fragmentation of the effective target (that is, the system of nucleons in the target nucleus along the axis of the incident proton) in proton-nucleus collisions. Correlation effects in violent processes are also briefly discussed.

3839 Low energy pion-nucleus scattering. Redwine, R.P. (Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *AIP (Am. Inst. Phys.) Conf. Proc.;* **54**: No. 1, 501-514(15 Jul 1979). (CONF-790347—).

From 2. international conference on meson-nuclear physics; Houston, TX, USA (5 Mar 1979).

Recent experiments on low energy pion-nucleus scattering are reviewed. Tere has been a significant increase in π^- scattering data at energies below 80 MeV. Analysis of an impressive amount of π^+ scattering data yields interesting systematic variation in optical model parameters. New experimental techniques and prospects for the near future are discussed.

3840 Statistical theory of pion-nucleus reactions near the (3,3) region. Agassi, D.; Koltun, D.S. (Physics Department, The University of Rochester, Rochester, New York 14627). *AIP (Am. Inst. Phys.) Conf. Proc.;* **54**: No. 1, 601-602(15 Jul 1979). (CONF-790347—).

From 2. international conference on meson-nuclear physics; Houston, TX, USA (5 Mar 1979).

Pion-nucleus scattering for bombarding energies in the (3,3) region is described in terms of a transport equation, following the propagation, diffusion and true-absorption of the Δ-isobar.

3841 Microscopic theory of the Δ spreading potential in a simple approach to pion-nucleus scattering. Brockmann, R.; Brown, G.E.; Jennings, B.K.; Rockmore, R.M. (State University of New York, Stony Brook, New York 11794). *AIP (Am. Inst. Phys.) Conf. Proc.;* **54**: No. 1, 618-619(15 Jul 1979). (CONF-790347—).

From 2. international conference on meson-nuclear physics; Houston, TX, USA (5 Mar 1979).

We explore the consequences of a simple optical model approach to pion-nucleus scattering, based on nuclear matter considerations. The introduction of a Δ spreading potential based on a microscopic low-energy model of pair excitation is a novel feature of our treatment.

3842 Microscopic, many-body approach to inelastic pion-nucleus scattering. Goy, A.A.; Vagradov, G.M. (AN SSSR, Moscow. Inst. Yadernykh Issledovanij); Silbar, R.R. (Los Alamos Scientific Lab., NM (USA)). *Phys. Lett., B;* **80**: No. 4, 335-339(15 Jan 1979).

The authors develop a microscopic, Fermi liquid approach to (π, π') scattering to low-lying final states. Application to excitation of a neutron particle-hole state in infinite nuclear matter shows that the ratio of π^- to π^+ cross sections is sensitive to Fermi liquid parameters.

3843 Nuclear interactions. Robson, B. (ed.). New York; Springer-Verlag (1978). 532p. (CONF-780854—).

From Conference on nuclear interactions; Canberra, Australia (28 Aug 1978).

The main topics of this conference were heavy-ion reactions and electromagnetic interactions. This volume contains the written versions of 29 invited talks and the summary talk. In addition, 113 contributed one-page abstracts and the closing remarks made at the conference are also included. Seven of the invited papers have already been abstracted in ERA, and these can be found by reference to the entry CONF-780854— in the Report Number Index. Additional papers will be processed for inclusion in the data base as they are received on ATOMINDEX tapes. (RWR)

3844 A-THREE: A general optical model code especially suited to heavy-ion calculations. Auerbach, E.H. (Brookhaven National Lab., Upton, NY). *Comput. Phys. Commun.;* **15**: 165-192(1978).

The code A-THREE, in which the optical model is used to solve heavy ion reactions is described. The program can be used on the CDC-7600 computer and is written in FORTRAN-extended. For this purpose the nonrelativistic radial Schroedinger equation with complex potential is solved partial wave by partial wave to obtain phase shifts, from which total reaction cross sections, elastic scattering and polarization angular distributions, are obtained. Provision is made to search for an eigenvalue or potential which produces a given eigenvalue in the bound state case, and to fit given data or sets of data, with or without angular resolution, in the scattering case. The parameter space may also be scanned without search. 21 references. (JFP)

NUCLEAR MODELS

REFER ALSO TO CITATION(S) 3790, 3839, 3840, 3841, 3844

RADIATION AND SHIELDING PHYSICS

RADIATION PHYSICS

REFER ALSO TO CITATION(S) 3760

3845 (ANL—78-65(Pt.1), pp 155-162) **Theory of the yields of initial molecular species under radiation action: generalizations of the Fowler equation.** Inokuti, M. 1978.

In Radiological and Environmental Research Division annual report: fundamental molecular physics and chemistry, October 1977-September 1978.

The standard Fowler equation concerns the mean yield of an initial species such as ions resulting from complete slowing-down of an electron of a given kinetic energy in a pure medium. Similar equations for two other cases are presented. The first applies to the proton incidence in a pure medium and the second to the electron incidence in a binary mixture. 7 references.

3846 Spatial excitation patterns induced by swift ions in condensed matter. Echenique, P.M.; Ritchie, R.H.; Brandt, W. (Health and Safety Research Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Phys. Rev., B: Condens. Matter;* **20**: No. 7, 2567-2580(1 Oct 1979).

It is shown that a charged particle moving with velocity v in a medium of resonance frequency Ω_0 may set up two types of electron-density fluctuations. Collective fluctuations trail the part cle, composing a conical pattern in a relatively extended periodi wake of wavelength $\sim 2\pi v/\Omega_0$. They constitute a mode of energ transport from the particle track leading eventually to particle-hol excitations. Single-particle interactions give rise to bow waves ahea of the particles of wavelength $2\pi\hbar/mv$. The gradient alorg v, at th site of the ion, of the wake potential set up by density fluctuation: multiplied by the ionic charge, yields an expression for the retardin$_g$ force of the medium on the projectile in exact agreement with the Bethe stopping-power formula appropriate to the medium. The wake of a dicluster causes forces between the constituent ions which account quantitatively for measurements of the breakup behavior of swift molecular ions in thin foils. The increase in the energy straggling of a test charge, when moving in the wake of a leading ion, is shown to be small compared with the straggling induced by its own wake under normal conditions.

3847 Transport-Diffusion Interfaces in Radiative Transfer. Pomraning, G.C.; Foglesong, G.M. (School of Engineering and Applied Science, University of California, Los Angeles, California 90024). *J. Comput. Phys.;* **32**: No. 3, 420-436(Sep 1979).

For radiative transfer problems involving both optically thick and thin regions, it is suggested that a coupled diffusion-transport treatment has certain advantages in numerical treatments. The well known Marshak (Milne) boundary treatment is extended in a straightforward way to give the connecting conditions at the diffusion-transport interface. It is found that these conditions give a diffusion radiative flux from a blackbody in excess of the physical blackbody limit. The Marshak conditions are modified to correct this discrepancy and the resulting diffusion description is found to be quite accurate for grey, as well as black, bodies. A previously suggested diffusion-transport interface treatment, due to Brockway, is discussed and shown to be a certain finite difference analogue of the unmodified Marshak treatment. The modification needed to give the correct black-body limit is applied to the Brockway formulation. The previously suggested interpretation of the Brockway equations in terms of probabilities leads to conceptual difficulties, and it is shown that such an interpretation is not needed to successfully apply these interface conditions.

3848 Infrared molecular saturation characteristics versus oscillator strength. Kung, R.T.V. (Avco Everett Research Lab., Inc., MA). *Chem. Phys. Lett.;* **57**: No. 2, 273-278(15 Jul 1978).

The high intensity transmission characteristics of a number of molecular gases were investigated at CO_2 laser wavelengths. The ratios of the low intensity absorption cross section to the high intensity absorption cross section were found to correlate with the square root of the oscillator strength of the particular molecular transition interesting with the laser frequency. 19 references.

NEUTRON INTERACTIONS WITH MATTER

3849 (ANL—78-65(Pt.1), pp 168-171) **Resonance transitions $2p^6$-$2p^53s$ in Ne-like ions.** Cheng, K.T.; Kim, Y.K. 1978.

In Radiological and Environmental Research Division annual report: fundamental molecular physics and chemistry, October 1977-September 1978.

The electric dipole transitions $(2p^6)^1S$-$(2p^53s)^1P^0$ in Ne-like ions are studied using the multiconfiguration Dirac-Fock method. Effects of spin-orbit interaction and interchannel couplings on oscillator strengths are discussed. 7 references.

3850 (BNL—26801) **Incommensurate structures.** Axe, J.D. (Brookhaven National Lab., Upton, NY (USA)). Oct 1979. Contract EY-76-C-02-0016. 24p. (CONF-790986—1). Dep. NTIS, PC A02/MF A01.

From Royal Society conference on neutron scattering in biology, chemistry, and physics; London, UK (26 Sep 1979).

A review is given of recent neutron scattering studies of displacive incommensurate structures, and the instabilities that occur within periodic crystalline structures that lead to their formation. The concept of a soft phonon, in some cases associated with an electronic screening anomaly, is useful but not always capable of a completely satisfactory description. An unusual one-dimensional liquid-like phase has been studied in the non-stoichiometric mercury compound, Hg/sub 3-δ/AsF$_6$.

3851 (NUREG/CR—0965) **Integral data evaluation of stainless steel, ^{239}Pu, ^{240}Pu, and H_2O for homogeneous plutonium systems.** Jenquin, U.P.; Thompson, J.K.; Trapp, T.J.; Kottwitz, D.A. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Aug 1979. Contract EY-76-C-06-1830. 78p. (PNL—3071). Dep. NTIS, PC A05/MF A01.

Theory-experiment correlations of plutonium-fueled systems using ENDF/B cross-section data have discrepancies which could be due to cross-section data, theoretical methods, and/or interpretation of the experiment. Analyses of homogeneous plutonium critical experiments were performed to determine where cross section deficiencies may exist. New thermal cross-section data (0.3 eV) were

generated for ^{239}Pu and ^{240}Pu capture, fission, and neutrons per fission. Two scattering kernels for hydrogen bound in water were also generated. Calculated values of k/sub eff/ using these new data were compared with corresponding values using ENDF/B-IV data. The results indicate that the ^{240}Pu resonance data are sufficiently well known for hydrogen-moderated plutonium systems. In systems using stainless steel as structural and/or neutron control, a large fraction of the neutron absorptions occur in the stainless steel. Analyses of several systems containing stainless steel indicate that the uncertainty in calculated values of k/sub eff/ is small using current estimates of the uncertainties in the cross sections. 20 figures, 30 tables.

SOLID STATE PHYSICS

REFER ALSO TO CITATION(S) 3314

3852 (BNL—26658) **Anomalous x-ray scattering.** Wendin, G. (Brookhaven National Lab., Upton, NY (USA)). 1979. Contract EY-76-C-02-0016. 30p. (CONF-7906128—1). Dep. NTIS, PC A03/MF A01.

From 46. Nobel symposium on many-body theory of atomic systems; Aspenasgarden, Lerum, Sweden (11 Jun 1979).

The availability of tunable synchrotron radiation has made it possible systematically to perform x-ray diffraction studies in regions of anomalous scattering near absorption edges, e.g. in order to derive phase information for crystal structure determination. An overview is given of recent experimental and theoretical work and discuss the properties of the anomalous atomic scattering factor, with emphasis on threshold resonances and damping effects. The results are applied to a discussion of the very strong anomalous dispersion recently observed near the L_3 edge in a cesium complex. Also given is an overview of elements and levels where similar behavior can be expected. Finally, the influence of solid state and chemical effects on the absorption edge structure is discussed. 64 references.

3853 **Theoretical description of quantum beats of recoil-free γ radiation.** Monahan, J.E.; Perlow, G.J. (Physics Division, Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev., A;* **20**: No. 4, 1499-1510(Oct 1979).

A classical optical theory is given for the phenomenon of γ-ray quantum beats observed by Perlow in a study of the Moessbauer effect of a frequency-modulated source. The intensity I (ω_0-ω_0't) of the radiation from such a source transmitted through a resonant absorber is obtained as a function of ω_0-ω_0' and t, where ω_0' is the frequency of an absorber resonance, ω_0 is the central frequency of the frequency-modulated source, and t is the laboratory time. An average is taken over the unobserved initial formation time of the excited nuclear state in the source. When viewed at fixed ω_0-ω_0', the calculated intensity displays beats in the time spectrum, and when viewed at fixed t, the intensity shows dispersion at appropriate values of ω_0-ω_0', responsible for the observed enhancement of intensity above background. The harmonic content of the quantum beats is calculated explicitly in the thin-absorber limit, and the observed linear variation about ω_0-ω_0'=0 of the ratio of Fourier components D_1/D_2 is explained. The use of D_1/D_2 to measure small frequency shifts is analyzed by a statistical comparison with the method of switching between steepest points of the line, as used in gravitational-red-shift measurements. The variances are comparable. The effect on I (ω3{-ω_0',t) of line broadening due to sample inhomogeneities is calculated for a Lorentz distribution of center frequencies in source and absorber, and a prescription is given for modifying the various terms in I (ω_0-ω_0',t) accordingly. Finally, the effect of a distribution of phase and amplitude of the motion of the vibrating source is discussed.

SUPERCONDUCTIVITY

ACOUSTIC, ELECTRIC, MAGNETIC, OPTICAL, AND THERMAL PHENOMENA

REFER ALSO TO CITATION(S) 3330, 3344, 3351, 3388

3854 (LA—8071-PR) **LASL Nb_3Ge conductor development. Twelfth quarterly progress report, April 1-June 30, 1979.** Maley, M.P. (comp.). (Los Alamos Scientific Lab., NM (USA)). 1979. Contract W-7405-ENG-36. 14p. Dep. NTIS, PC A02/MF A01.

The twelfth quarterly progress report of the Los Alamos Scientific Laboratory program to develop Nb_3Ge as a superconductor with potential applications to superconducting power transmission (SPT) lines covers the period April 1-June 30, 1979. During this period a total of 56 m of Nb_3Ge-clad tape were produced by the CVD process for fabrication of the first 1.0-m test section of superconducting transmission line. After sections of the tapes were tested for acceptable critical current density J/sub c/, the first two layers were wrapped in the helical manner prescribed by the Brookhaven National Laboratory (BNL) SPT project. A total of six voltage probes were installed and insulating tapes were wrapped. Only the outer two layers of the conductor remain to be wrapped for completion of the test section. Additional studies have continued on the influence of Nb_3Ge_3 on J/sub c/ in our modified CVD apparatus.

THEORETICAL PHYSICS

CLASSICAL AND QUANTUM MECHANICS

REFER ALSO TO CITATION(S) 3770, 3775, 3778, 3861

3855 (ORO—3992-367) **Reintroducing the concept of force into relativity theory.** Mahajan, S.; Qadir, A.; Valanju, P. (Texas Univ., Austin (USA). Center for Particle Theory). Jul 1979. Contract EY-76-S-05-3992. 37p. Dep. NTIS, PC A03/MF A01.

It is suggested that re-introducing forces into relativity theory may provide new insights and results. A look at the Kerr-Newmann geometry, and special cases of it, from this viewpoint indicates that there can be a short range repulsion in general. This repulsion suggests that naked singularities may be physically feasible. It is also found that there is a gravito-electric repulsion which would be important to consider in a grand unification scheme of strong, weak and electromagnetic forces. 8 references.

3856 **Guiding center Hamiltonian: A new approach.** Littlejohn, R.G. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *J. Math. Phys. (N.Y.);* **20**: No. 12, 2445-2458(Dec 1979).

A Hamiltonian treatment of the guiding center problem is given which employs noncanonical coordinates in phase space. Separation of the unperturbed system from the perturbation is achieved by using a coordinate transformation suggested by a theorem of Darboux. As a model to illustrate the method, motion in the magnetic field B=B (x,y) z is studied. Lie transforms are used to carry out the perturbation expansion.

3857 **Coherent states for general potentials. II. Confining one-dimensional examples.** Nieto, M.M.; Simmons, L.M. Jr. (Theoretical Division, Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87545). *Phys. Rev., D;* **20**: No. 6, 1332-1341(15 Sep 1979).

We apply our minimum-uncertainty coherent-states formalism, which is physically motivated by the classical motion, to two confining one-dimensional systems: the harmonic oscillator with centripetal barrier and the symmetric Poeschl-Teller potentials. The minimum-uncertainty coherent states are discussed in great detail, and the connections to annihilation-operator coherent states and displacement-operator coherent states are given. The first system discussed provides an excellent bridge between the harmonic oscillator and more general potentials because, even though it is a nonharmonic potential, its energy eigenvalues are equally spaced. Thus, its coherent states have many, but not all, of the properties of the harmonic-oscillator coherent states.

3858 **Coherent states for general potentials. III. Nonconfining one-dimensional examples.** Nieto, M.M.; Simmons, L.M. Jr. (Theoretical Division, Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87545). *Phys. Rev., D;* **20**: No. 6, 1342-1350(15 Sep 1979).

We apply our minimum-uncertainty coherent-states (MUCS) formalism to two one-dimensional systems that have continua: the symmetric Rosen-Morse potential and the Morse potential. The coherent states are discussed analytically in great detail, and the connections to annihilation-operator and displacement-operator coherent states are given. For the Rosen-Morse system the existence of a continuum does not prevent one from obtaining the coherent states in analytic, closed form. The Morse system, with its energy-dependent natural classical variable X/sub c/, has a natural quantum operator X which is Hamiltonian-dependent. This Hamiltonian dependence is complicated and prevents an easy analytic solution for the MUCS. However, approximate MUCS can be obtained by analytic approximation techniques.

OPTICS

REFER ALSO TO CITATION(S) 3853

3859 **Polydisperse-particle-size-distribution function determined from intensity profile of angularly scattered light.** Alger, T.W. (University of California, Lawrence Livermore Laboratory, Livermore, California 94550). W-7405-ENG-48. *Appl. Opt.;* **18**: No. 20, 3494-3501(15 Oct 1979).

A new method for determining the particle-size-distribution function of a polydispersion of spherical particles is presented. The inversion technique for the particle-size-distribution function is based upon matching the measured intensity profile of angularly scattered light with a summation of the intensity contributions of a series of appropriately spaced, narrowband, size-distribution functions. A numerical optimization technique is used to determine the strengths of the individual bands that yield the best agreement with the measured scattered-light-intensity profile. Because Mie theory is used, the method is applicable to spherical particles of all sizes. Several numerical examples demonstrate the application of this inversion method.

3860 ATR method with focused light: application to guided waves on a grating. Kretschmann, E. (Oak Ridge National Lab., TN). *Opt. Commun.;* **26**: No. 1, 41-44(Jul 1978).

The attenuated total reflection (ATR) method was modified by using focused light. The reflected light then contains information about a large region in k-space. This and other advantages are discussed. When applied to the investigation of guided waves on a grating, their dispersion relation with band gaps and discontinuities can be seen on a screen. 3 figures.

MATHEMATICAL PHYSICS

REFER ALSO TO CITATION(S) 3856

3861 (UCID—18185) **LCPT: a program for finding linear canonical transformations.** Char, B.W.; McNamara, B. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 21 May 1979. Contract W-7405-ENG-48. 31p. Dep. NTIS, PC A03/MF A01.

This article describes a MACSYMA program to compute symbolically a canonical linear transformation between coordinate systems. The difficulties in implementation of this canonical small physics problem are also discussed, along with the implications that may be drawn from such difficulties about widespread MACSYMA usage by the community of computational/theoretical physicists.

3862 (UCRL-Trans—11492) **Solutions to wave equations using an artificial viscosity method.** Goloviznin, V.M.; Samarskii, A.A.; Favorskii, A.P. (AN SSSR, Moscow. Inst. Prikladnoj Matematiki). Jun 1979. Translation of Preprint No. 70, 1976. 39p. Dep. NTIS, PC A03/MF A01.

Earlier work on systems of differential-difference and difference equations (DDDE) that model the behavior of an inelastic continuum in the absence of dissipative processes imposed a strong constraint on the class of problems treated by excluding flows with shock waves accompanied by increasing entropy. To lift this constraint some form of artificial viscosity must be introduced. This work treats linear artificial viscosity, which has the property that it does not distort the eigenfunctions of the original DDDE linearized about the equilibrium position. The numerical value of the coefficient in the presence of such artificial viscosity is selected on the basis of the condition of the most rapid attenuation of the high-frequency oscillations defined by the linearized equations. When such artificial viscosity is selected, it proves possible to investigate completely the problem of the stability of linearized systems of equations in two-dimensional Cartesian and cylindrical coordinates in arbitrary (irregular) calculation meshes. The subject is treated under the following headings: original DDDE; artificial viscosity; linearization of the original equations - the acoustic approximation; analysis of the linear approximation for one-dimensional DDDE; analysis of the linear approximation for two-dimensional DDDE; algorithm for finding the optimal coefficient using artificial viscosity; and investigation of the stability of linearized DDDE. The equations solved describe the behavior of noninteracting harmonic and difference oscillators. (RWR)

FUSION ENERGY

PLASMA RESEARCH

PLASMA CONFINEMENT AND HEATING

REFER ALSO TO CITATION(S) 3894, 3895, 3905

3863 (UCID—18314) **Physics parameter calculations for a Tandem Mirror Reactor with thermal barriers.** Boghosian, B.M.; Lappa, D.A.; Logan, B.G. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 6 Nov 1979. Contract W-7405-ENG-48. 30p. Dep. NTIS, PC A03/MF A01.

Thermal barriers are localized reductions in potential between the plugs and the central cell, which effectively insulate trapped plug electrons from the central cell electrons. By then applying electron heating in the plug, it is possible to obtain trapped electron temperatures that are much greater than those of the central cell electrons. This, in turn, effects an increase in the plug potential and central cell confinement with a concomitant decrease in plug density and injection power. Ions trapped in the barrier by collisions are removed by the injection of neutral beams directed inside the barrier cell loss cone; these beam neutrals convert trapped barrier ions to neutrals by charge exchange permitting their escape. We describe a zero-dimensional physics model for this type of reactor, and present some preliminary results for Q.

3864 Shape stability for a plasma contained within a standing electromagnetic field. Ensley, D.L. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). *Phys. Fluids;* **22**: No. 12, 2359-2363(Dec 1979).

For an over-dense plasma located within a resonant cavity and surrounded by standing electromagnetic radiation, it is shown that shape stability depends only on the ratio of the mean plasma radius (r/sub a/) to the wavelength of the surrounding radiation. For an initial cavity mode wavenumber k_{10}, stability occurs for k_{10} raitalicfrequency ν/sub lambda/ is shown to scale linearly with λ (the order of the surface wave), ν/sub lambda/ remains small compared with the electromagnetic field frequency for stable plasmas. These results are of significance in designing inertial fusion experiments in which intense electromagnetic fields are used for heating and compressing a dense plasma.

3865 High beta stellarator stability theory. Schmidt, M.J. (Courant Institute of Mathematical Sciences, New York University, New York, New York 10012). *Phys. Fluids;* **22**: No. 12, 2400-2407(Dec 1979).

An analytic study of the stability of a straight diffuse high beta stellarator with arbitrary wall corrugation is presented. It is found that a solvability condition for the equilibrium of such a plasma is intimately related to a sufficient condition for stability. The results of the calculation suggest that if the equilibrium model is valid, then all high beta stellarators are unstable.

3866 Transport and radiation studies of belt pinches and high-beta tokamaks. Byrne, R.N.; Chu, C.K. (Science Applications, Inc., La Jolla, California 92038). *Phys. Fluids;* **22**: No. 12, 2418-2423(Dec 1979).

Transport and radiation effects on eliptical cross-section pinch machines have been performed using the G2m code. Profile effects are shown to be small for machines of the general parameters of Torus I at Columbia and significant for those like Torus II. An explanation of toroidal paramagnetism is advanced.

3867 Stochastic ion heating by a lower hybrid wave: II. Karney, C.F.F. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08544). *Phys. Fluids;* **22**: No. 11, 2188-2209(Nov 1979).

The motion of an ion in a coherent lower hybrid wave (characterized by vertical-bark/sub parallel/vertical-bar$<<$vertical-bark/sub perpendicular/vertical-bar and $\omega >> \Omega$/sub i/) in a tokamak plasma is studied. For ions satisfying v/sub perpendicular/$>\omega$/k/sub perpendicular/, the Lorentz force law for the ions is reduced to a set of difference equations which give the Larmor radius and phase of an ion on one cyclotron orbit in terms of these quantities a cyclotron period earlier. These equations exhibit stochastic behavior when the wave amplitude exceeds a threshold. The stochasticity threshold is given a simple physical interpretation. In addition, the difference equations are used to derive a diffusion equation governing the heating of the ions above the stochasticity threshold. Far above the stochasticity threshold, ion Landau damping is recovered. By including the effects of collisions, the heating rate for the bulk ions is obtained.

PLASMA DIAGNOSTICS

3868 (UCRL—83208) **Optical design of the TMX Thomson Scattering Diagnostic.** Frank, A.M. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 7 Nov 1979. Contract W-7405-ENG-48. 6p. (CONF-791102—6). Dep. NTIS, PC A02/MF A01.

From 8. symposium on engineering problems of fusion research; San Francisco, CA, USA (13 Nov 1979).

The Thomson Scattering Diagnostic on TMX was built to measure the electron temperature in the plug. The design was based on the 2XII system built by Tom Simonen. Substantial improvements were realized over the original design, these include: (1) improved sensitivity, (2) simultaneous multiple position sampling, (3) multiple pulse capability, (4) achromatic imaging, (5) vacuum alignment capability, (6) high reliability, and (7) built in calibration and performance monitoring.

3869 Ion temperature and neutral density measurements in the direct current octopole by induced optical fluorescence. Lipson, J. (General Atomic Company, San Diego, California 92138). *Phys. Fluids;* **22**: No. 11. 2236-2240(Nov 1979).

A continuous wave tunable dye laser, operating with a broadband (0.5 A bandwidth) or with a locked single mode output (10^{-4} A bandwidth) was used to investigate the local density and velocity distribution of sodium metal neutrals present in a magnetically confined laser produced sodium metal plasma. With the broadband input, the intensity of fluorescence is proportional to the local neutral density. From the temporal evolution of this quantity, it is possible to evaluate the importance of resonance charge exchange in establishing ion energy balance, and also the effectiveness of the limiters in retaining neutralized ions. With the locked single mode input, the structure of the velocity distribution is accessible. Specifically, when the plasma is seeded with additional sodium neutrals from an external oven source, the charge exchange products achieve sufficient concentration for the neutral Doppler profile to acquire recognizable wings. The ion temperature is readily obtained from the width of these wings.

PLASMA KINETICS - GENERAL

3870 (INIS-mf—4754(No.7)) **International bulletin on atomic and molecular data for fusion. No. 7.** Katsonis, K.; Smith, F.J. (eds.). (International Atomic Energy Agency, Vienna (Austria). Nuclear Data Section). Jan 1979. 55p. Dep. NTIS (US Sales Only), PC A04/MF A01.

This bulletin deals with atomic and molecular data for fusion. A bibliography for the most recent data presented in the document is provided. Work in progress is briefly reported. The bulletin contains an extensive list of references covering the years 1977 and 1978 for all the publications on control fusion and plasma physics.

PLASMA KINETICS - EXPERIMENTAL

3871 (LA-UR—79-2867) **Data discrepancies in and new experiments for D+D, D+T, and T+T fusion reactions.** Jarmie, N.; Hardekopf, R.A.; Brown, R.E.; Correll, F.D.; Ohlsen, G.G. (Los Alamos Scientific Lab., NM (USA)). 1979. Contract W-7405-ENG-36. 6p. (CONF-791058—6). Dep. NTIS, PC A02/MF A01.

From International conference on nuclear cross sections for technology; Knoxville, TN, USA (22 Oct 1979).

The purpose of this work is to investigate the accuracy of the basic fusion reaction data for the reactions $T(d,n)^4He$, $T(t,2n)^4He$, $D(d,n)^3He$, and D(d,p)T, and to describe an elaborate experiment in progress at the Los Alamos Scientific Laboratory to remeasure the cross sections with improved accuracy.

3872 (PPPL—1589) **Regimes of operation in the Princeton Large Torus.** Hosea, J.C. (Princeton Univ., NJ (USA). Plasma Physics Lab.). Oct 1979. Contract EY-76-C-02-3073. 14p. Dep. NTIS, PC A02/MF A01.

In the quest for optimum discharge conditions in the Princeton Large Torus (PLT), a variety of discharge regimes have been produced. These separate broadly into two main categories - those regimes with $m \geq 2$ oscillatory MHD instabilities and often hollow electron profiles for tungsten limiters, and those regimes for which the electron temperature is sufficiently peaked to support the internal sawtooth or near-sawtooth ($m = 1$) instability. The internal sawtooth regime is found to be optimum for confinement but to be more difficult to select when low-Z impurity concentrations have been reduced with low power discharge cleaning or gettering to permit extension of the high density operation limit. Gas programming is used to cool the plasma periphery, thereby reducing the high-Z impurity concentrations and causing the current channel to constrict into the sawtooth regime, and then to attain the desired plasma density. With discharges selected in this manner, gross energetic confinement times up to $\sim$ 100 msec have been obtained at densities of $\sim 10^{14}$ cm^{-3}, and very high ion and electron temperatures have been produced with neutral beam injection heating at lower densities with no observable deleterious effect on energy confinement.

3873 (PPPL—1592) **Techniques for measuring the alpha-particle distribution in magnetically confined plasmas.** Post, D.E.; Mikkelsen, D.R.; Hulse, R.A.; Stewart, L.D.; Weisheit, J.C. (Princeton Univ., NJ (USA). Plasma Physics Lab.). Oct 1979. Contract EY-76-C-02-3073. 55p. Dep. NTIS, PC A04/MF A01.

Methods are proposed for measuring the alpha-particle distribution in magnetically confined fusion plasmas using neutral-atom doping beams, ultraviolet spectroscopy, and neutral particle detectors. In the first method single charge exchange reactions, $A^0 + He^{++} \rightarrow A^+ (He^+)^*$, are used to populate the n=2 and n=3 levels of He^+. The ultraviolet photons from the decaying excited states are Doppler shifted by 5 to 10 Angstroms from those produced by the thermalized alpha-particle ash. In the second method double charge exchange reactions, $A^0 + He^{++} \rightarrow A^{++} + He^0$, enable fast neutralized alpha-particles to escape from the plasma and be detected by neutral particle analysers. Detector configurations are analyzed, count rates are estimated and their detectability is discussed. A preliminary analysis of the feasibility of the required neutral beams is presented, and exploratory experiments on existing devices are suggested.

3874 Observations of a highly collisional toroidal plasma equilibrium. Allen, A.W.; Antoniades, J.A.; Goldenbaum, G.C. (Department of Physics and Astronomy, University of Maryland, College Park, Maryland 20742). *Phys. Fluids;* **22**: No. 12, 2394-2399(Dec 1979).

The time evolution of temperature and density profiles in a finite beta, noncircular cross section (b/a=2) toroidal plasma (R_o/a=2) has been measured. Measurements show ion temperatures decreasing as the density is increasing along the major radius at the z=0 midplane. For these conditions, the electron temperature remains approximately uniform over the cross section. A recent theoretical model for highly collisional circular cross section plasma predicts qualitatively similar temperature and density profiles which are different from those for the less collisional Pfirsch—Schlueter regime.

3875 Measuring the electron heat diffusion coefficient in a tokamak from sawtooth oscillation observations. Soler, M. (Junta de Energia Nuclear, Madrid (Spain)); Callen, J.D. (Oak Ridge National Lab., TN (USA)). *Nucl. Fusion;* **19**: No. 6, 703-714(Jun 1979).

A number of new methods are discussed for determining the electron heat conduction coefficient chisub(e) in a tokamak from the experimental observation of the space-time evolution of the temperature perturbations induced by internal disruptions. In the Oak Ridge Tokamak (ORMAK) the various average values of chisub(e) and the radial dependence of chisub(e) are found to be consistent with and more precise than the chisub(e)(r) determined by conventionally analysing the electron power balance equation. The net result of these measurements is to conclusively prove that the dominant radial electron heat transport mechanism in tokamaks is a microscopic, diffusive process.

PLASMA KINETICS - THEORETICAL

3876 (LA—8064-MS) **Normal ionizing shock as a theta pinch preionizer.** DeSilva, A. (Los Alamos Scientific Lab., NM (USA)). Oct 1979. Contract W-7405-ENG-36. 21p. Dep. NTIS, PC A02/MF A01.

The normal ionizing shock wave is considered as a potential preionizer for high density ($\geqq$ 15 mtorr), high bias field ($\geqq$ 1 kG) theta pinches. Available experimental data compare well with the theory of Kunkel and Gross. Limitations to the validity of the theory due to finite ionization rate, and to radial plasma drift are determined.

3877 (LBL—8185) **Nonlinear wave evolution in VLASOV plasma: a lie-transform analysis.** Cary, J.R. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Aug 1979. Contract W-7405-ENG-48. 295p. Dep. NTIS, PC A13/MF A01.

Nonlinear wave evolution in Vlasov plasma is analyzed using the Lie transform, a powerful mathematical tool which is applicable to Hamiltonian systems. The first part of this thesis is an exposition of the Lie transform. Dewar's general Lie transform theory is explained and is used to construct Deprit's Lie transform perturbation technique. The basic theory is illustrated by simple examples.

3878 (PPPL—1605) **Fallacies in some theories of the renormalized dielectric.** Krommes, J.A. (Princeton Univ., NJ (USA). Plasma Physics Lab.). Nov 1979. Contract EY-76-C-02-3073. 28p. Dep. NTIS, PC A03/MF A01.

Several popular theories of the renormalized dielectric are examined and shown to be logically flawed. A recent conclusion that the weak-coupling approximation to the renormalized quasilinear dielectric is divergent is shown to be misleading because of an improper definition of the dielectric. The usual resonance-broadened dielectric is shown to be in error because the approximation neglects subtle correlations of the same order and physical importance as the terms retained. The problem is traced specifically to an erroneous application of statistical averaging and to the often-ignored difference between the infinitesimal response function and the single particle propagator. The procedure of resonance-broadening the non-adiabatic response is discussed, but no justification for the usual form of this approximation is found.

3879 (UCID—18302) **Mathematical models for the RINGBEARER simulation code.** Chambers, F.W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 22 Aug 1979. Contract W-7405-ENG-48. 20p. Dep. NTIS, PC A02/MF A01.

RINGBEARER is a particle simulation code for modelling an electron beam propagating in a gas characterized by a space and time varying conductivity generated by the beam. The code has two spatial dimensions, the beam is assumed to be axially symmetric. Equations for the beam driven pinch field, the plasma density, and

the conductivity are given along with the appropriate initial conditions and boundary conditions. The equations governing particle energy loss, transverse motion, and scattering, in the beam generated pinch field are presented. The analytic models used in the code are presented with either references or derivations.

3880 Kinetic theory of evolution of anisotropic plasmas. Pao, Y. (Courant Institute of Mathematical Sciences, New York University, New York, New York, 10012). *Phys. Fluids;* **22**: No. 12, 2315-2323(Dec 1979).

A kinetic theory is constructed to evaluate the evolution and motion of an anisotropic axisymmetric plasma caused by collisional effects and pressure anisotropy. The relationship to neoclassical transport theory is also discussed.

3881 Production and flow of plasma in ion beams. Hooper, E.B. Jr.; Anderson, O.A.; Willmann, P.A. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). *Phys. Fluids;* **22**: No. 12, 2334-2345(Dec 1979).

Steady plasma flow is analyzed for the case where a positive- or negative-ion beam penetrates and ionizes background gas (or vapor). The work of previous authors is extended to treat nonuniform beam densities that fall to low values at the transverse plasma boundary, and to include gas densities that are nonuniform along the beam axis. These nonuniformities give a two-dimensional plasma flow problem that is analyzed using a fluid model. The effect of unusually low gas density on the plasma flow is discussed; for negative-ion beams, the electron density becomes much smaller than the beam density and space-charge neutralization is maintained by a reduction in plasma flow. When there is a large local gas density, as in a gas cell, the resulting high electron density is also localized to the same region by the nature of the flow.

3882 Convective cells and transport in toroidal plasmas. Hassam, A.B.; Kulsrud, R.M. (Department of Physics and Astronomy, University of Maryland, College Park, Maryland 20742). *Phys. Fluids;* **22**: No. 11, 2097-2107(Nov 1979).

The properties of convective cells and the diffusion resulting from such cells are significantly influenced by an inhomogeneity in the external confining magnetic field, such as that in toroidal plasmas. It is shown, first, that the zero-frequency convective cell of the homogeneous medium (vortex) is transformed into the interchange flute mode in the presence of the field inhomogeneity. For stable interchange profiles, this has the effect of reducing the step size of the diffusion process. Second, in an inhomogeneous field, convective motions damp by magnetic pumping at a rate typically much faster than perpendicular viscous damping. This reduces the lifetime of the cell. The convective diffusion in the presence of a field inhomogeneity is estimated. For a thermal background, this diffusion is shown to be substantially smaller than classical diffusion. The influence of the field inhomogeneity is also shown to be significant for nonthermal backgrounds.

3883 Pseudo-classical transport in a sheared magnetic field: Theory and simulation. Nevins, W.M.; Harte, J.; Gell, Y. (Electronics Research Laboratory, University of California, Berkeley, California 94720). *Phys. Fluids;* **22**: No. 11, 2108-2121(Nov 1979).

The cross-field transport due to the trapping of electrons in a finite amplitude wave (pseudo-classical transport) is investigated. Both finite wave frequencies and magnetic shear are included. The single particle orbit equations are solved to obtain the trapping criterion as well as the trapped particle orbit width and bounce frequency. Using a random walk model, the scaling of the pseudo-classical transport coefficients with the parameters of the plasma and wave are deduced. This scaling is employed to extend a previous calculation of the transport coefficients to include magnetic shear which is found to reduce these transport coefficients. Computer simulations of this transport process are presented. The measured transport rates are in very good agreement with the previous kinetic calculation in the absence of magnetic shear and with this extension of pseudo-classical transport theory which includes magnetic shear.

3884 Aspects of a renormalized weak plasma turbulence theory. Krommes, J.A.; Kleva, R.G. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08544). *Phys. Fluids;* **22**: No. 11, 2168-2177(Nov 1979).

A renormalized Vlasov turbulence theory, derived by neglecting a mode coupling term in the direct interaction approximation, is discussed. The theory reduces correctly to weak turbulence theory; it predicts both diffusion and polarization effects of the turbulent medium on test particles, as well as the inverse effects of the test particles on the medium. A heuristic, physical algorithm is presented for constructing the equations. The theory of the renormalized dielectric function is reviewed.

3885 Interpretive method for studying effects of strong magnetic shear on plasma equilibrium and stability. Mynick, H.E. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *Phys. Fluids;* **22**: No. 11, 2210-2215(Nov 1979).

A graphical technique is developed which is useful for understanding the effects of magnetic shear on particle orbits and plasma stability. This technique is, in principle, as precise as its algebraic counterpart, but its chief advantage lies in enabling one to develop qualitative expectations for the mathematical results, and to discern their physical meaning. Several effects on individual particle motion and collective phenomena are discussed, among them the modification by shear of the particle gyrofrequency, and a generalized expression for the diamagnetic drift frequency.

3886 Elongated field-reversed plasma equilibria. Kadish, A. (U. S. Department of Energy, Washington, D. C. 20545). *Phys. Fluids;* **22**: No. 11, 2248-2249(Nov 1979).

A simple analysis of field-reversed equilibria is presented which includes toroidal effects. The location of elongated sharp boundary plasma columns is determined as a function of the ratio of open to closed magnetic fluxes and the location of material boundaries.

3887 Guiding-center Hamiltonian for arbitrary gyration. Mynick, H.E. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *Phys. Rev. Lett.;* **43**: No. 14, 1019-1022(1 Oct 1979).

A systematic procedure for deriving the guiding-center Hamiltonian K is described, valid for arbitrary ratio of particle gyroscale length to perpendicular magnetic scale length. Practical examples are given where the method permits an explicit evaluation of K for cases where the small-gyroradius approximation used for standard guiding-center theories is invalid.

3888 Accessibility of high-beta tokamak states. Hogan, J.T. (Oak Ridge National Lab., TN (USA)). *Nucl. Fusion;* **19**: No. 6, 753-776(Jun 1979).

Encouraging results with neutral-beam heating and adiabatic compression of tokamak plasmas have prompted new experiments which will study the approach to high-β states. As projected tokamak β-values become non-negligible (average β of 4% is the goal), the models previously used for transport calculations will become inadequate. The models will now be required to account for the evolution of the magnetic geometry, along with the change in plasma parameters. An axisymmetric-transport model is presented, which should be useful for studying the approach to higher β-values in tokamak experiments. Results from transport calculations with this model allow an analysis of the limits to β in two seemingly unrelated experiments: electron heating by neutral injection in the ORMAK device and adiabatic compression in the ATC experiment. By extrapolating empirical models for plasma transport, it is found that flux conserving (FCT) equilibria ought to be accessible by means of neutral-beam heating. Finally, it is found that the nature of cross-field transport may be expected to change as significant β-values are reached. Enhanced transport from ballooning instabilities is likely to play a role as important as that now played by sawtooth (m=1) and saturated (m=2) instabilities. New techniques for describing this transport are required.

PLASMA PRODUCTION

REFER ALSO TO CITATION(S) 3881

3889 (COO—4631-8) Experimental test of resonant absorption theory. Annual progress report, January 1, 1979-December 31, 1979. Yablonovitch, E. (Harvard Univ., Cambridge, MA (USA)). Sep 1979. Contract ED-78-S-02-4631. 10p. Dep. NTIS, PC A02/MF A01.

New results are reported on the angular and energy spectrum of resonantly accelerated electrons from a shock front as measured by a miniature β-ray spectrometer. We have devised a multichannel electron collector based on printed circuit board technology. It has been multiplexed into a fast oscilloscope to provide a complete absolute spectrum on a single laser shot.

3890 Coaxial lower hybrid plasma source. Motley, R.W.; Bernabei, S.; Hooke, W.M. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08540). *Rev. Sci. Instrum.;* **50**: No. 12, 1586-1589(Dec 1979).

We report the development of a coaxial radio frequency plasma source capable of producing pulsed plasmas of moderately high density (10^{13}—10^{14} cm^{-3}). This device may be useful either as a general purpose laboratory plasma source or as an auxilliary source for a variety of fusion applications, such as providing target plasmas for mirror machines or producing cold plasma blankets to help isolate the hot plasma core of a toroidal plasma from the walls.

PLASMA INSTABILITIES

REFER ALSO TO CITATION(S) 3864, 3865

3891 (GA-A—15353) **BLOON users' manual.** Moore, R.W. (General Atomic Co., San Diego, CA (USA)). Sep 1979. Contract AT03-76ET51011. 57p. Dep. NTIS, PC A04/MF A01.

The General Atomic Company ballooning mode stability code, BLOON, calculates the stability of numerically generated tokamak equilibria to ideal MHD pressure-driven modes. This report gives a summary of the input and output used by the Cray version of BLOON.

3892 (ORO—5260-3) **Nonlinear magnetohydrodynamics. Progress report, December 15, 1978-December 31, 1979.** Vahala, G.; Montgomery, D. (College of William and Mary, Williamsburg, VA (USA)). 1979. Contract EY-76-S-05-5260. 16p. Dep. NTIS, PC A02/MF A01.

The problem of nonlinear incompressible magnetohydrodynamic stability is considered. The absolute equilibrium states for initially quiescent systems are determined. The basic procedures used in the study are described. (MOW)

3893 (PPPL—1597) **Magnetic driving energy of the tearing mode.** Adler, E.A.; Kulsrud, R.M.; White, R.B. (Princeton Univ., NJ (USA). Plasma Physics Lab.). Oct 1979. Contract EY-76-C-02-3073. 21p. Dep. NTIS, PC A02/MF A01.

The change in the magnetic energy density produced by a tearing mode is calculated exactly. The driving energy for the mode is found to come entirely from the region inside the tearing layer, although there is also a displacement of energy in the outer region which integrates to zero. The total change in magnetic energy is exactly equal to the change in a quadratic form related to a variational principle for the full resistive equations.

3894 Vlasov-fluid stability of a rigidly rotating theta pinch. Seyler, C.E. (University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *Phys. Fluids;* **22**: No. 12, 2324-2330(Dec 1979).

The stability of a rigidly rotating theta pinch is investigated using the Vlasov-fluid model. The main differences between the present and the asymptotic theory are due to the effect of resonant ions present in the exact Vlasov-fliud equations. An analytical explanation of the resonant ion effects is given.

3895 Parametric instabilities and ion heating in a two ion-species plasma. Lin, C.C.; Lin, A.T.; Okuda, H. (Center for Plasma Physics and Fusion Engineering, University of California, Los Angeles, California 90024). *Phys. Fluids;* **22**: No. 12, 2331-2333(Dec 1979).

Parametric instabilities and the associated ion heating in the presence of two-ion species have been studied using a one-dimensional, quasi-neutral particle simulation model. At an early stage the heating is due to trapping or resonance heating of the decay waves. When the average Larmor radius reaches half the excited electrostatic wavelength, the heating becomes stochastic.

3896 Stabilization of trapped-electron shear-Alfven instabilities by temperature gradient. Ross, D.W.; Mahajan, S.M.; Hazeltine, R.D.; Strauss, H.R. (Fusion Research Center, University of Texas at Austin, Austin, Texas 78712). *Phys. Fluids;* **22**: No. 12, 2364-2366(Dec 1979).

Localized shear-Alfven modes with large m numbers are shown, numerically, to be strongly damped by the collisionless electron response in the presence of a temperature gradient. The trapped-electron drift-tearing instability is stabilized by this effect in a tokamak unless the inverse aspect ratio exceeds a critical value, typically between 0.1 and 0.2. Analytical models demonstrate the scaling of these results with plasma parameters.

3897 Wave-particle interaction in the late beam-plasma instability. Freese, K.B.; Walsh, J.E.; Lohr, J. (Department of Physics and Astronomy, Dartmouth College, Hanover, New Hampshire 03755). *Phys. Fluids;* **22**: No. 12, 2367-2376(Dec 1979).

Experiments are reported on the beam-plasma instability at times after saturation when the electron distribution function exhibits a high energy tail. The results show that high energy electrons are produced by a velocity resonant wave-particle interaction. The experiments were formed on quite different devices at Dartmouth College and The University of Texas; however, the results from the two laboratories are consistent.

3898 Poloidal mode ballooning of trapped electron instability. Pandey, S.R.; Ross, D.W. (Fusion Research Center, The University of Texas at Austin, Austin, Texas 78712). *Phys. Fluids;* **22**: No. 12, 2389-2393(Dec 1979).

The effect of the magnetic moment dependence of the bounce averaged toroidal drift velocity on the eigenvalues and poloidal structure of the trapped electron mode is investigated in the radially local model. It is found that eigenvalues from the magnetic moment dependent dispersion relation deviate significantly from those of the constant drift velocity approximation for negative and large positive shear values. However, for shear ranging from $rq^{-1}\,dq/dr = 0.5$ to 1.5, the trapped electron magnetic drift frequency can be approximated by $\omega/sub\ d/ew\ (0.4 + 0.8rq^{-1}dq/dr)$, where $\omega/sub\ d/e$ is a constant, w is the particle kinetic energy, and q is the safety factor.

3899 Coalescence of magnetic islands. Pritchett, P.L.; Wu, C.C. (Department of Physics, University of California, Los Angeles, California 90024). *Phys. Fluids;* **22**: No. 11, 2140-2146(Nov 1979).

A detailed numerical analysis has been conducted of the instability described by Finn and Kaw in which parallel currents in neighboring islands tend to coalesce into larger units. The existence of this coalescence instability in the ideal magnetohydrodynamic limit is confirmed, but no evidence is found for a threshold in island width. The linear growth rates are found to be rapid compared with those for purely resistive processes, and the linear mode structure has only a weak dependence on resistivity. In the nonlinear regime, saturation of the mode in the ideal case is observed due to flux piling up at the X point, while in the nonideal case the merging process is observed to proceed to completetion.

3900 Unified theory of tearing modes. Mahajan, S.M.; Hazeltine, R.D.; Strauss, H.R.; Ross, D.W. (Fusion Research Center, The University of Texas at Austin, Austin, Texas 78712). *Phys. Fluids;* **22**: No. 11, 2147-2157(Nov 1979).

A unified theory of tearing modes in slab geometry is presented. All known results are readily derived from our general dispersion relations. Several new results are derived and discussed, and the inter-relatonship between various tearing modes is established.

3901 Instability condition for confined waves with ergodic ray trajectories. Ott, E. (University of Maryland, College Park, Maryland 20740). *Phys. Fluids;* **22**: No. 11, 2246(Nov 1979).

Unstable plasma waves which follow ergodic ray trajectories in a confined region are considered. It is argued that under certain circumstances, application of the ergodic theorem yields a useful method for calculating growth rates and stability thresholds.

3902 Dependence of ideal-MHD kink and ballooning modes on plasma shape and profiles in tokamaks. Todd, A.M.M.; Manickam, J.; Okabayashi, M.; Chance, M.S.; Grimm, R.C.; Greene, J.M.; Johnson, J.L. (Princeton Univ., NJ (USA). Plasma Physics Lab.). *Nucl. Fusion;* **19**: No. 6, 743-752(Jun 1979).

Extensive numerical studies of ideal-MHD instabilities have been carried out to gain insight into the parametric dependence of critical β's in tokamaks. The large number of interrelated equilibrium quantities involved in establishing a critical β has demanded a careful, systematic survey in order to isolate this dependence. The results of this survey establish the scaling with geometrical quantities including aspect ratio, elongation, and triangularity in the parameter regimes appropriate to both current and reactor-sized plasmas. A moderate dependence on the pressure profile and a strong variation with the current profile is found. The principal result is that, for aspect ratio R/a approximately 3, critical β's are of the order of 2% for circular cross-sections and 5% for plasmas with elongation K approximately 2; somewhat higher values could be achieved with more optimal shaping. Finally, sequences of equilibria have been analysed to compare critical β as a function of toroidal mode number n. It is concluded that the infinite-n analytic ballooning theory provides a sufficient condition for ideal-MHD internal-mode stability. Low-n free-boundary modes appear to set a lower limit.

PLASMA WAVE PHENOMENA

REFER ALSO TO CITATION(S) 3864, 3867, 3896, 3897

3903 Axial eigenmodes for long -λ/sub parallel/ waves in plasmas bounded by sheaths. Chen, F.F. (TRW Defense and Space Systems Group, Redondo Beach, California 90278). *Phys. Fluids;* **22**: No. 12, 2346-2358(Dec 1979).

Waves such as drift waves and lower hybrid oscillations in a plasma are sensitive to the degree to which charge neutrality can be maintained by electron flow along the magnetic field. When the plasma is bounded axially, the sheath conditions on the end plates determine the parallel wavelength. It is found that the nature of the bounded modes depends on whether the motion of electrons is resistive or inertial. If it is resistive, the sheath matching conditions can be satisfied by standing waves with the proper wavelength. If it is inertial, pure standing waves are not possible; there must also be a variation of phase along B. Application is made to two-ion hybrid waves in connection with isotope separation.

3904 Dynamic interaction of intense microwaves with plasma. Mizuno, K.; DeGroot, J.S. (Department of Applied Science, University of California, Davis, California 95616). *Phys. Fluids;* **22**: No. 11, 2229-2231(Nov 1979).

The ponderomotive force of the parametrically excited electron plasma waves drastically modifies the density profile. The asymptotic density profile has a subcritical density plateau followed by a density jump to supercritical densities which reduces the

parametric instabilities, as observed in particle simulation calculations.

3905 Study of driven lower-hybrid waves in the Alcator tokamak using CO_2-laser scattering. Surko, C.M.; Slusher, R.E.; Schuss, J.J.; Parker, R.R.; Hutchinson, I.H.; Overskei, D.; Scaturro, L.S. (Bell Laboratories, Murray Hill, New Jersey 07974). *Phys. Rev. Lett.;* **43**: No. 14, 1016-1019(1 Oct 1979).

The wavelengths, amplitudes, frequencies, and spatial distributions of driven lower-hybrid wave fluctuations are studies in the Alcator tokamak with use of CO_2-laser scattering. It is found that for incident microwave power densities from 0.4 to 4.5 kW/cm^2 the wave amplitudes are nearly independent of the relative phase of the electric fields at the exciting waveguides. The waves are not localized in resonant cones and they have frequency widths of from 0.5 to 6 MHz.

FUSION POWER PLANT TECHNOLOGY

3906 (COO—2218-141) **CTR plasma engineering studies. Annual progress report, October 1, 1978-September 30, 1979.** Miley, G.H. (Illinois Univ., Urbana (USA). Fusion Studies Lab.). 1979. Contract EY-76-S-02-2218. 192p. Dep. NTIS, PC A09/MF A01.

The current plasma engineering studies report on three major areas of fusion reactor development. Plasma engineering studies of the field-reversed mirror (FRM) have focused on stability, start-up, and fusion product heating and leakage. A Monte Carlo technique has been developed to study high-energy fusion product transport in the FRM. The stability studies involve use of a perturbation theory applied to orbits calculated with the SUPERLAYER code. Studies of the reversed-field pinches (RFP) have centered around development of a 1-D dynamic MHD code which is designed to investigate enhanced transport, cold particle fueling, fusion product heating, and stability limits. Rotation effects in the field-reversed theta pinch (FRTP) have been examined as a preliminary step in understanding its potential use in a reactor concept such as the moving plasmoid heater (MPH), also briefly examined here. Studies of fusion-product transport effects in tokamaks include plasma heating, blister-induced first wall erosion, and ash buildup limitations on burn time. Finally, other mirror systems studies have been concerned with both first-wall bombardment and plasma buildup during neutral beam injection.

3907 (DOE/ET—0115/1) **Discussion of criteria for evaluating initial TMX experiments.** Ellis, W.R. (Department of Energy, Washington, DC (USA). Office of Fusion Energy). Aug 1979. 33p. Dep. NTIS, PC A03/MF A01.

The purpose of this report is to define and discuss the initial results from the Tandem Mirror Experiment (TMX) at Lawrence Livermore Laboratory (LLL) which may be used to evaluate whether the basic tandem mirror (TM) concept is working as expected. The purpose of TMX, the first significant size tandem mirror device to operate in this country or elsewhere, is to provide a proof-of-principle evaluation of the TM concept as rapidly as possible. Preliminary results from the only other tandem mirror facility in operation, the Gamma-6 facility at Nagoya University in Japan (which is much smaller), indicate that no gross MHD instabilities are present at the densities and temperatures obtained in that machine, and that the axial electrostatic potential profile is formed as expected.

3908 (DOE/ET—0116/1) **Fusion technology development.** (Department of Energy, Washington, DC (USA). Office of Fusion Energy). Aug 1979. 148p. Dep. NTIS, PC A07/MF A01.

This report includes information on the following chapters: (1) conceptual design studies, (2) magnetics, (3) plasma heating, fueling, and exhaust, (4) materials for fusion reactors, (5) alternate applications, and (6) environment and safety. (MOW)

3909 (LA—8045-P) **Proposal for FRX-C and multiple-cell Compact Torus experiments.** Dreicer, H. (Los Alamos Scientific Lab., NM (USA)). Oct 1979. Contract W-7405-ENG-36. 139p. Dep. NTIS, PC A07/MF A01.

A Compact Torus (CT) is a configuration for plasma confinement that offers possible engineering advantages for fusion power generation such as small size, simple blanket geometry, natural divertor, and spatially separable functions of plasma production and fusion energy generation. Two experiments to study the physics and technology of some particular CT configurations are proposed here as part of the LASL Compact Torus Program Plan. One experiment, FRX-C, is designed to study CT stability and transport properties by scaling the parameters of the existing FRX-B field-reversed theta-pinch experiment to higher temperatures, larger size, and increased plasma lifetime. The second experiment, a modification of the existing Scylla IV-P device, would form a linear array of CTs with the aim of understanding the effect on CT transport of improved plasma confinement on the open field lines outside the separatrix, as well as other multiple-cell effects.

3910 (NRL-MR—4092) **Development of imploding liner systems for the NRL LINUS program.** Turchi, P.J.; Burton, R.L.; Cooper, A.L.; Ford, R.D.; Jenkins, D.J.; Cameron, J.; Lanham, R. (Naval Research Lab., Washington, DC (USA)). 28 Sep 1979. Contract EX-76-A-34-1006. 14p. Dep. NTIS, PC A02/MF A01.

Some progress has been made both experimentally and conceptually in regard to plasmas that could be compressed by liner implosion, but no experimental test has yet been accomplished successfully in which the energy and temperature of the magnetically-confined plasma has been increased into a significant regime by liner implosion. Considerable progress has been made, however, in developing liner implosion techniques suitable for both experimental development and eventual imploding liner fusion reactors. The principal development has been the achievement of controlled, reversible liner implosions with excellent symmetry and surface quality. The paper reviews some of the highlights of th development of liner implosion systems at the Naval Research Laboratory and indicates directions of future work.

3911 (UCRL—52836) **Tandem mirror reactor with thermal barriers.** Carlson, G.A.; Arfin, B.; Barr, W.L.; Boghosian, B.M.; Erickson, J.L.; Fink, J.H.; Hamilton, G.W.; Logan, B.G.; Myall, J.O.; Neef, W.S. Jr. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 19 Sep 1979. Contract W-7405-ENG-48. 210p. Dep. NTIS, PC A10/MF A01.

This report gives detailed information in the form of the following chapters: (1) overview, (2) plasma physics, (3) magnets, (4) end-plug neutral beams, (5) barrier pump neutral beams, (6) ecr heating, (7) plasma direct converter, and (8) central cell. (MOW)

3912 (UCRL—82790) **Magnetic mirror confinement of high-energy, high-density plasma.** Coensgen, F.H.; Simonen, T.C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 21 Aug 1979. Contract W-7405-ENG-48. 18p. Dep. NTIS, PC A02/MF A01.

This paper summarizes results obtained from and work in progress on those experiments which have contributed significantly toward the confinement in single-cell magnetic mirror systems of plasmas close to thermonuclear conditions. Because the mirror confinement of such high-energy, high-density plasmas has been studied most extensively in the 2XIIB experiment, discussion of 2XIIB results forms a major portion of this paper. In these experiments, injection of low-energy plasma has been shown to suppress microinstabilities to sufficiently low levels that high-beta ($\beta \simeq 1$) plasmas could be achieved and sustained by cross-field injection of beams of neutral particles. Plasma confinement was found to improve with ion energy, electron temperature, and plasma size. Based on these results, a larger Mirror Fusion Test Facility (MFTF) was designed to pursue confinement scaling to higher energies and larger plasma dimensions. MFTF design parameters and construction status are briefly reviewed.

3913 (UCRL—82791) **Tandem mirror and field-reversed mirror experiments.** Coensgen, F.H.; Simonen, T.C.; Turner, W.C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 21 Aug 1979. Contract W-7405-ENG-48. 24p. Dep. NTIS, PC A02/MF A01.

This paper is largely devoted to tandem mirror and field-reversed mirror experiments at the Lawrence Livermore Laboratory (LLL), and briefly summarizes results of experiments in which field-reversal has been achieved. In the tandem experiment, high-energy, high-density plasmas (nearly identical to 2XIIB plasmas) are located at each end of a solenoid where plasma ions are electrostatically confined by the high positive poentials arising in the end plug plasma. End plug ions are magnetically confined, and electrons are electrostatically confined by the overall positive potential of the system The field-reversed mirror reactor consists of several small field-reversed mirror plasmas linked together for economic reasons. In the LLL Beta II experiment, generation of a field-reversed plasma ring will be investigated using a high-energy plasma gun with a transverse radial magnetic field. This plasma will be further heated and sustained by injection of intense, high-energy neutral beams.

3914 (WFPS-TME—79-023) **User's manual for COAST 4: a code for costing and sizing tokamaks.** Sink, D.A.; Iwinski, E.M. (Westinghouse Electric Corp., Pittsburgh, PA (USA). Fusion Power Systems Dept.). Sep 1979. Contract EG-77-C-02-4544. 156p. Dep. NTIS, PC A08/MF A01.

The purpose of this report is to document the computer program COAST 4 for the user/analyst. COAST, COst And Size Tokamak reactors, provides complete and self-consistent size models for the engineering features of D-T burning tokamak reactors and associated facilities involving a continuum of performance including highly beam driven through ignited plasma devices. TNS (The Next Step) devices with no tritium breeding or electrical power production are handled as well as power producing and fissile producing

fusion-fission hybrid reactors. The code has been normalized with a TFTR calculation which is consistent with cost, size, and performance data published in the conceptual design report for that device. Information on code development, computer implementation and detailed user instructions are included in the text.

BLANKET ENGINEERING

REFER ALSO TO CITATION(S) 3370, 3372

3915 (GA-A—15594) **Influence of nuclear data uncertainties on thorium fusion-fission hybrid blanket nucleonic performance.** Cheng, E.T.; Mathews, D.R. (General Atomic Co., San Diego, CA (USA)). Sep 1979. Contract AT03-76ET51011. 10p. (CONF-791058—2). Dep. NTIS, PC A02/MF A01.

From International conference on nuclear cross sections for technology; Knoxville, TN, USA (22 Oct 1979).

The fusion-fission hybrid blanket proposed for the Tandem Mirror Hybrid Reactor employs thorium metal as the fertile material. Based on the ENDF/B-IV nuclear data, the ^{233}U and tritium production rate and blanket energy multiplication averaged over the blanket lifetime of about 9 MW-yr/m^2 are 0.76 and 1.12 per D-T neutron and 4.8, respectively. At the time of the blanket discharge, the ^{233}U enrichment in the thorium metal is about 3%. The thorium cross sections given by the ENDF/B-IV and V were reviewed, and the important partial cross sections such as (n,2n), (n,3n), and (n,γ) were found to be known to +-10 to 20% in the respective energy range of interest. A sensitivity study showed that the ^{233}U and tritium production rate and blanket energy multiplication are relatively sensitive to the thorium capture and fission cross section uncertainties. In order to predict the above parameters within +-1%, the Th(n,γ) and Th(n,νf) cross sections must be measured within about +-2% in the energy range 3 to 3000 keV and 13.5 to 15 MeV, respectively.

MAGNET COILS AND FIELDS

REFER ALSO TO CITATION(S) 3486, 3487, 3922

3916 (AD-A—063373) **Generation of a reversed field configuration without an applied magnetic field. Interim report.** Sethian, J.D.; Gerber, K.A.; Spector, D.N.; Robson, A.E. (Naval Research Lab., Washington, DC (USA)). Aug 1978. 15p. NTIS PC A02/MF A01.

A rotating relativistic electron beam, charge- but not current-neutralized and exceeding the Alfven limit, has been propagated down a closed metal tube in the absence of an external guide field. The radial equilibrium is determined by the self-fields of the beam and the induced wall currents. The 100 nsec duration beam, upon leaving the system, induces plasma currents that maintain a field reversed configuration for 18 microseconds. (Author)

3917 (UCRL—15097) **Quench Detection and Magnet Protection Study for MFTF. LLL final review.** (Intermagnetics General Corp., Guilderland, NY (USA)). Jun 1979. Contract W-7405-ENG-48. 82p. Dep. NTIS, PC A05/MF A01.

The results of a Quench Detection and Magnet Protection Study for MFTF are summarized. The study was directed toward establishing requirements and guidelines for the electronic package used to protect the MFTF superconducting magnets. Two quench detection schemes were analyzed in detail, both of which require a programmable quench detector. Hardware and software recommendations for the quench detector were presented as well as criteria for dumping the magnet energy in the event of a quench. Overall magnet protection requirements were outlined in a detailed Failure Mode Effects and Criticality analysis, (FMECA). Hardware and software packages compatible with the FMECA were recommended, with the hardware consisting of flexible, dedicated intelligent modules specifically designed for magnet protection.

3918 (UCRL—82913) **Cryogenic aspects of the mirror fusion test facility.** Sterbentz, W.H.; Nelson, R.L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 8 Nov 1979. Contract W-7405-ENG-48. 5p. (CONF-791102—2). Dep. NTIS, PC A02/MF A01.

From 8. symposium on engineering problems of fusion research; San Francisco, CA, USA (13 Nov 1979).

This paper covers the design and construction of the MFTF cryogenic system and a description of the operating procedures throughout the many functional modes. The coils and the cryopanels for maintaining the high vacuum environment weigh 417,000 kg (920,000 lb) and must be cooled from room temperature to 4.5 k. The cryogenic system for MFTF consists of a closed-loop helium system with a 3000-W helium refrigerator that uses gas-bearing expansion turbines and oil-flooded screw compressors. In addition, liquid helium storage facilities have adequate capacity for standby operation, and a complete helium-purification plant is capable of processing 17 m^3/min (600 scfm). An open-loop liquid nitrogen system (with provision for later addition of a nitrogen recondenser) provides the required refrigeration for the radiation shields that must be maintained at 85 K.

POWER SUPPLIES, ENERGY STORAGE

REFER ALSO TO CITATION(S) 3087, 3088

HEATING AND FUELING SYSTEMS

3919 (LBL—9997) **Outgassing measurements and results used in designing the Doublet III Neutral Beam Injector System.** Yamamoto, R.M.; Harvey, J. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Nov 1979. Contract W-7405-ENG-48. 8p. (CONF-791102—8). Dep. NTIS, PC A02/MF A01.

From 8. symposium on engineering problems of fusion research; San Francisco, CA, USA (13 Nov 1979).

Material vacuum properties played an important part in designing the Neutral Beam Injector System for General Atomic's Doublet III Tokamak. Low operating vacuum tank pressures were desired to keep re-ionization of the Neutral Beam to a minimum. Plasma contamination was also a major concern, hence stringent material impurity constraints were imposed. Outgassing Rate Measurement and Residual Gas Analyses were performed on different types of materials to determine if their vacuum properties were compatible with the Neutral Beam Injector System requirements.

3920 (ORNL/TM—6896) **ISX-B neutral beam injector experiment on a prototype beam line.** Kim, J.; Stirling, W.L.; Menon, M.M.; Dagenhart, W.K.; Barber, G.C.; Davis, R.C.; Haselton, H.H.; Schechter, D.E.; Tsai, C.C. (Oak Ridge National Lab., TN (USA)). Sep 1979. Contract W-7405-ENG-26. 44p. Dep. NTIS, PC A03/MF A01.

Two PLT-injector-type duoPIGatron sources, modified further by shaping the beam-forming apertures, have been tested and experimented on a prototype beam line similar to the ISX-B neutral beam injection system. The accelerator column modification has resulted in an increase of the beam power transmission efficiency from that of the straight-bore aperture by 50%. Maximum neutral beam powers achieved on a 28-cm-diam target simulating the ISX-B plasma, located 4.1 m downstream from the source, are congruent to 910 kW of H^0 at an accelerator power of 42 kV and 61 A and congruent to 1020 kW of D^0 at 43 kV and 55 A. Measurements have been made to investigate the following: the effects on beam optics of aperture shape, aspect ratio, and different ions (H^+ or D^+); the distribution of beam power deposition along the beam line; ion species compositions; and background pressure behavior due to scraped-off beam particles.

3921 (ORNL/TM—6944) **Beam steering due to displaced slots.** Whealton, J.H.; McGaffey, R.W.; Jaeger, E.F. (Oak Ridge National Lab., TN (USA)). Sep 1979. Contract W-7405-ENG-26. 14p. Dep. NTIS, PC A02/MF A01.

Using a two-dimensional algorithm, steering of triode slots was investigated for the first time with a reasonable accounting of the ion extraction sheath.

3922 (UCRL—52824) **Magnetic shielding of neutral beam sources in mirror fusion test facility.** Shearer, J.W.; Cutler, T.A.; Dilgard, L.W.; Fabyan, J.; Holl, P.M.; Porter, G.D.; Colonias, J.S. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 15 Aug 1979. Contract W-7405-ENG-48. 33p. Dep. NTIS, PC A03/MF A01.

The magnetic shields of the Mirror Fusion Test Facility neutral beam sources must keep the inner magnetic field below 0.15 mT inside an unsymmetrical ambient magnetic field of 0.05 to 1.5 T. Numerical computations and 1/10th-scale experiments were used to arrive at a three-layer shield design consisting of two thin nickel-iron alloy shells inside a thick mild steel shell. A 1/10th-scale prototype test confirmed the final design.

3923 **Impurity behaviour during neutral-beam injection and gas puffing into ORMAK.** Isler, R.C.; Crume, E.C.; Howe, H.C. (Oak Ridge National Lab., TN (USA)). *Nucl. Fusion;* **19**: No. 6, 727-742(Jun 1979).

Variations of the intensities of spectral lines are utilized to determine the extent to which the impurity concentrations of ORMAK-produced plasmas are altered by neutral-beam injection and, in some cases, by the simultaneous introduction of a puff of hydrogen. Concurrent variations of oxygen emissions resulting from alterations in the profiles of electron temperatures and concentrations are taken into account through solving the coupled continuity equations of the several ionic species of this element. Ad-hoc transport velocities are utilized and a complete re-cycling model is assumed.

TRITIUM PROCESSING, ENVIRONMENT AND SAFETY

3924 (COO—2431-5) **Uncertainties in modeling of consequences of tritium release from fusion reactors. Plasma Fusion Center No**

PFC/TR-79-5. Piet, S.J.; Kazimi, M.S. (Massachusetts Inst. of Tech., Cambridge (USA)). Jul 1979. Contract EY-76-S-02-2431. 184p. Dep. NTIS, PC A09/MF A01.

The bases for various models concerned with all phases of estimating doses from routine tritium releases from fusion reactors have been examined. The implications of uncertainties in parameters and assumptions for the uncertainty of the calculated doses and resulting maximum permissible releases are presented. Global dispersion models are most affected by the assumptions made concerning movement, such as the role of the ocean as a sink. Dose models were generally found to agree within a factor of two, with the largest variation due to agricultural data. Plant tritium flow studies are the least developed and require substantial improvement in the data base. Based on two possible arbitrary global standards, the maximum allowable releases were found to range from 1.6 to 20,000 Ci/day. The local criteria imply releases between 5 and 20 Ci/day.

3925 (DOE/EV—0046(Vol.2), pp 11-22) **Materials resource cycle of fusion power plants.** Willenberg, H.J.; Kabele, T.J.; May, R.P.; Willingham, C.E. (Battelle Pacific Northwest Labs., Richland, WA). Sep 1979.

From Environmental control symposium; Washington, DC, USA (28 Nov 1978).

The materials resource cycle for a fusion power plant includes facilities for deuterium separation and extraction, lithium mining and milling, power plant operation, and waste storage and recycle. Work in progress at PNL characterizes each of these facilities in a conceptual manner in terms of materials flow, processes used, and proximity to the power plant. Emphasis during the first phase of the program has been on the post-reactor-shutdown part of the materials resource cycle. Various blanket design options have been compared. Methods for offgassing of tritium after shutdown have been investigated. The degree to which materials may be recycled in both liquid lithium and in solid breeding modules has been explored. Ease of disassembly has been revealed as an important factor in determining the degree to which blanket materials may be recycled.

INERTIAL CONFINEMENT TECHNOLOGY

REFER ALSO TO CITATION(S) 3536

3926 Heavy ion accelerators and storage rings for pellet fusion reactors. Martin, R.L.; Arnold, R.C. (Argonne National Lab., IL (USA)). *Nucl. Instrum. Methods;* **155**: No. 3, 337-345(1 Oct 1978).

Heavy ion accelerators and storage rings in the multi-GeV energy regime can be utilized for inertial-confinement fusion. A discussion is presented of design parameters for some systems, based on existing accelerator technology, capable of delivering beams of order 100 terawatt to a pellet millimeters in diameter. A specific conceptual design for an 8 GeV system, using a beam of iodine ions, is described in some detail.

3927 (LA-UR—79-2757) **Antares: a status report.** Stine, R.D. Jr. (Los Alamos Scientific Lab., NM (USA)). 1979. Contract W-7405-ENG-36. 14p. (CONF-791047—2). Dep. NTIS, PC A02/MF A01.

From 11. annual electro optics/laser conference and exposition; Anaheim, CA, USA (23 Oct 1979).

Antares is the Los Alamos Scientific Laboratory 100-kJ CO_2 laser driver for inertial confinement fusion experiments. The status of the various Antares subsystems is discussed. These subsystems consist of facilities, front end, energy storage, power amplifier, target, optical alignment and diagnostics, large optics, and controls. The installation of Antares is underway and the schedule to permit experiments which may lead to breakeven in 1984 is discussed.

3928 (SAND—79-1748) **Optimization of the particle pusher in a diode simulation code.** Theimer, M.M.; Quintenz, J.P. (Sandia Labs., Albuquerque, NM (USA)). Sep 1979. Contract EY-76-C-04-0789. 21p. Dep. NTIS, PC A02/MF A01.

The particle pusher in Sandia's particle-in-cell diode simulation code has been rewritten to reduce the required run time of a typical simulation. The resulting new version of the code has been found to run up to three times as fast as the original with comparable accuracy. The cost of this optimization was an increase in storage requirements of about 15%. The new version has also been written to run efficiently on a CRAY-1 computing system. Steps taken to affect this reduced run time are described. Various test cases are detailed.

3929 (UCRL—81673) **Heat transfer in inertial confinement fusion reactor systems.** Hovingh, J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 14 May 1979. Contract W-7405-ENG-48. 18p. (CONF-790802—77). Dep. NTIS, PC A02/MF A01.

From International conference on structural mechanics in reactor technology; Berlin, F.R. Germany (13 Aug 1979).

The transfer of energy produced by the interaction of the intense pulses of short-ranged fusion microexplosion products with materials is one of the most difficult problems in inertially-confined fusion (ICF) reactor design. The short time and deposition distance for the energy results in local peak power densities on the order of 10^{16} watts/m^3. High local power densities may cause change of state or spall in the reactor materials. This will limit the structure lifetimes for ICF reactors of economic physical sizes, increasing operating costs including structure replacement and radioactive waste management. Four basic first wall protection methods have evolved: a dry-wall, a wet-wall, a magnetically shielded wall, and a fluid wall. These approaches are distinguished by the way the reactor wall interfaces with fusion debris as well as the way the ambient cavity conditions modify the fusion energy forms and spectra at the first wall. Each of these approaches requires different heat transfer considerations.

3930 (UCRL—82041) **Material implications of design and system studies for inertial confinement fusion systems.** Maniscalco, J.A.; Meier, W.R. (Exxon Research and Engineering Co., Linden, NJ (USA); California Univ., Livermore (USA). Lawrence Livermore Lab.). Dec 1978. Contract W-7405-ENG-48. 11p. (CONF-790125—82). Dep. NTIS, PC A02/MF A01.

From 1. topical meeting on fusion reactor materials; Miami Beach, FL, USA (29 Jan 1979).

The major material requirements for inertial confinement fusion (ICF) reactors are presented. These requirements are defined and analyzed by first describing the environment created from the process of generating energy with ICF, and then analyzing the ICF reactor concepts which have been designed to cope with this hostile environment.

3931 (UCRL—82835(Rev.1)) **Progress of laser fusion at Lawrence Livermore Laboratory.** Ahlstrom, H.G. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Jul 1979. Contract W-7405-ENG-48. 63p. (CONF-790708—5(Rev.1)). Dep. NTIS, PC A04/MF A01.

From XIV conference internationale sur les phenomenes d'ionisation dans les gaz; Grenoble, France (9 Jul 1979).

The Shiva and Nova programs are briefly reviewed. Some target diagnostics are described. Some laser-plasma interaction experiments are discussed. (MOW)

3932 (UCRL—83342) **Consequences of intensity constraints on inertial confinement fusion.** Kidder, R.E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 13 Sep 1979. Contract W-7405-ENG-48. 18p. (CONF-791109—1). Dep. NTIS, PC A02/MF A01.

From 5. workshop on laser interaction; Rochester, NY, USA (5 Nov 1979).

It is shown that the conflicting requirements of high implosion efficiency (low corona temperature) and adequate energy transport (high corona temperature) can, together with other effects, limit useful infrared light intensities to values on the order of 100 Tw/cm^2. Increased interest in ultraviolet lasers, for which this intensity constraint is expected to be less severe, and the entry of charged-particle drivers in the inertial confinement fusion (ICF) competition are consequences of this limitation. Analytical results based on a simple model are presented which show how the gain of an ICF target is modified by the existence of an arbitrary intensity constraint.

3933 Assessment of surface-heating problems in laser-fusion reactors. Abdel-Khalik, S.I.; Hunter, T.O. (Nuclear Engineering Department and Fusion Technology Program, University of Wisconsin, Madison, Wisc.). *J. Heat Transfer;* **100**: No. 2, 311-318(May 1978).

The surface-heating problems associated with the pulsed photon and ion irradiations of the first walls and liners of inertially-confined fusion reactor cavities are investigated. Analytical models for predicting the thermal response of these surfaces as a function of the different design and operational parameters of the system and the nature of the incident irradiations are developed. The effectiveness of residual gas as a means for protecting the wall from the ions and soft X-rays is assessed.

COMPONENT DEVELOPMENT AND MATERIALS TESTING

REFER ALSO TO CITATION(S) 3930

3934 (ORNL/SUB—7503/1) **Evaluation of a committed fusion site. Final report.** (Bechtel National, Inc., San Francisco, CA (USA)). Jul 1979. Contract W-7405-ENG-26. 266p. Dep. NTIS, PC A12/MF A01.

This report is divided into five technical sections. Section 2 is a summary. In Section 3, which covers device and site analyses the major characteristics of devices that might be placed at the site, as envisioned by major fusion laboratories, are described; the characteristics of a site (baseline site) which would accommodate these devices are defined; and various approaches to a committed site meeting the baseline site requirements are discussed. Section 4 de-

scribes the scenarios selected to represent possible site development outcomes; these scenarios are evaluated with respect to comparative cost and schedule effects. Section 5 presents a brief evaluation of the effects fusion-fission hybrids might have on the committed site. Major conclusions and recommendations are discussed in Section 6.

3935 (UCRL—82914) **Design of the MFTF external vacuum system.** Holl, P.M. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 13 Nov 1979. Contract W-7405-ENG-48. 11p. (CONF-791102—5). Dep. NTIS, PC A02/MF A01.

From 8. symposium on engineering problems of fusion research; San Francisco, CA, USA (13 Nov 1979).

As a result of major experiment success in the LLL mirror program on start-up and stabilization of plasmas in minimum-B magnetic geometry, a Mirror Fusion Test Facility (MFTF) is under construction. Completion is scheduled for September, 1981. MFTF will be used to bridge the gap between present day small mirror experiments and future fusion-reactor activity based on magnetic mirrors. The focal point of the Mirror Fusion Test Facility is the 35 foot diameter by 60 foot long vacuum vessel which encloses the superconducting magnets. High vacuum conditions in the vessel are required to establish and maintain a plasma, and to create and deliver energetic neutral atoms to heat the plasma at the central region.

GENERAL AND MISCELLANEOUS

MANAGEMENT

REFER ALSO TO CITATION(S) 2680, 3157

3936 (DOE/CR—0001/4) **DOE Uniform Contractor Reporting System: use of data handbook.** (Department of Energy, Washington, DC (USA). Office of the Controller). Sep 1979. 44p. Dep. NTIS, PC A03/MF A01.

This handbook is intended as an aid to project management within DOE by delineating ways in which data provided by the Uniform Contractor Reporting System (UCRS) can be evaluated and analyzed. Such evaluation and analysis can serve as one of the bases for the review of contractors' progress and of project status, and for forecasting future performance trends. The various methods for analysis, interpretation, display, and evaluation of UCRS data suggested in the handbook can be tailored or combined to fit specific cases. This handbook is not all-encompassing. 22 figures.

3937 (SAND—79-0522(Vol.5)(No.1)) **Sandia technology.** Lawrence, R.J.; Mead, P.L. (eds.). (Sandia Labs., Albuquerque, NM (USA)). May 1979. Contract EY-76-C-04-0789. 28p. Dep. NTIS, PC A03/MF A01.

Individual abstracts were prepared for sections on the geoenergy technology program, instrumentation for earth resource extraction, drilling research and development, and process research for energy extraction.

MATHEMATICS AND COMPUTERS

REFER ALSO TO CITATION(S) 2391, 2474, 2475, 2476, 2477, 2692, 3642

3938 (BNL—26729) **Differential geometric methods for solving nonlinear constrained optimization problems and a related system of nonlinear equations: global analysis and implementation.** Tanabe, K. (Institute of Statistical Mathematics, Tokyo (Japan); Brookhaven National Lab., Upton, NY (USA)). 1978. Contract EY-76-C-02-0016. 11p. (CONF-7811143—1). Dep. NTIS, PC A02/MF A01.

From International congress on numerical methods for engineering; Paris, France (27 Nov 1978).

Robust method that can produce convergence from a very poor initial estimate of the optimal solution for larger problems are discussed. A differential geometric method is developed specifically to obtain robust algorithms without resorting to the penalty-type approach. In particular, a generic class of feasibility-improving gradient acute projection (FIGAP) methods and their Levenberg-Marquardt-type modifications is developed for solving the general nonlinear constrained minimization problems. Each method in this class is an amalgamation of a generalized gradient projection method and a generalized Newton-Raphson method which, respectively, take care of reducing the value of the objective function and satisfying constraint equations at the same time. The class of FIGAP methods contains various new methods as well as many of the existing methods. A unified theory is developed for the methods by using extensively the concept of various generalized inverses and related projectors, which facilitates geometric interpretation of the FIGAP methods. Analysis is given to the continuous analogs of the methods to obtain robust algorithms, which also gives insight into the global behavior of the related algorithms. Various new algorithms are derived from the general theory that use the QR decomposition, the SVD decomposition and other decompositions of the Jacobian matrix of the constraint functions. Quasi-Newton algorithms which estimate projected Hessian matrix and require in some cases only approximations of nonnegative definite matrix of size n-m are developed to enhance the local convergence, where n and m are numbers of variables and constraint equations, respectively. 1 figure. (RWR)

3939 (CONF-791016—2) **Use of 3/sup n/ parallel flats fractional factorial designs in computer code uncertainty analysis.** Anderson, D.A.; Mardekian, J.; Rasmuson, D.M. (Wyoming Univ., Laramie (USA). Dept. of Statistics; EG and G Idaho, Inc., Idaho Falls (USA)). 1979. Contract EY-76-C-07-1570. 24p. Dep. NTIS, PC A02/MF A01.

From 1979 DOE statistical symposium; Gatlinburg, TN, USA (24 Oct 1979).

Parallel flats fractions for the 3/sup n/ factorial provide near-othogonal designs for which sets of treatment combinations (flats) can be run sequentially with analysis after each flat. For the 3/sup n/ factoral the number of parameters involved including the mean, main effects, and a two-factor interactions is $1 + 2n + 4(/\text{sup } n/_2) = 1 + 2n^2$. In most applications a relatively small number of these will be significant, and a design which will produce a good fit in relatively few runs is desired. The concepts and the sequential analysis are illustrated using a 3^4 example and a 3^8 example. Potential areas of application of these designs are discussed. 5 tables.

3940 (LA—8068-MS) **Robustness of Fisher's linear discriminant function to departures from normality.** Johnson, M.E.; Wang, C.; Ramberg, J.S. (Los Alamos Scientific Lab., NM (USA)). Oct 1979. Contract W-7405-ENG-36. 33p. Dep. NTIS, PC A03/MF A01.

A Monte Carlo investigation of the robustness of Fisher's linear discriminant function to departures from the normal distribution is presented. The Johnson system of distributions is used. 37 tables.

3941 (ORNL/CSD—47) **Balancing the generalized eigenvalue problem.** Ward, R.C. (Oak Ridge National Lab., TN (USA)). Oct 1979. Contract W-7405-ENG-26. 44p. Dep. NTIS, PC A03/MF A01.

An algorithm is presented for balancing the A and B matrices prior to computing the eigensystem of the generalized eigenvalue problem $Ax = \lambda Bx$. The three-step algorithm is specifically designed to precede the QZ-type algorithms, but improved performance is expected from most eigensystem solvers. The balancing algorithm computes permutations and two-sided diagonal transformations which are applied to A and B to produce matrices with certain desirable properties. Test cases are presented to illustrate the improved accuracy of the computed eigenvalues. 3 tables.

3942 (ORO—3443-84) **Finite element method for the Tricomi problem.** Aziz, A.K.; Werschulz, A. (Maryland Univ., College Park (USA). Inst. for Physical Science and Technology; Maryland Univ., College Park (USA). Dept. of Mathematics). Jul 1979. Contract EY-76-S-05-3443. 17p. (BN—913). Dep. NTIS, PC A02/MF A01.

The numerical solution of a class of second-order equations of elliptic-hyperbolic type for phi(x) by the finite element method is addressed by solution of the equivalent first-order system for the gradient of phi. Subspaces must lie in $H^1(\Omega)$, where Ω is a bounded region of the (x_1,x_2) plane. The problem to be solved is described first. Then an a priori error estimate is proved, and the coercivity of the bilinear form to be used is established. Next, the finite-element method for general subspaces is described, and a general error bound is established. Finally, it is shown that the L_2 rate of convergence for linear elements may be increased from O(h) to O(h/sup 3/2/) by writing the subspace as a direct sum in a new way. (RWR)

3943 (PNL-SA—8004) **ALDS 1978 panel review.** Hall, D.L. (ed.). (Battelle Pacific Northwest Labs., Richland, WA (USA)). Aug 1979. Contract EY-76-C-06-1830. 180p. Dep. NTIS, PC A09/MF A01.

Pacific Northwest Laboratory (PNL) is examining the analysis of large data sets (ALDS). After one year's work, a panel was convened to evaluate the project. This document is the permanent record of that panel review. It consists of edited transcripts of presentations made to the panel by the PNL staff, a summary of the responses of the panel to these presentations, and PNL's plans for the development of the ALDS project. The representations of the PNL staff described various aspects of the project and/or the philosophy surrounding the project. Supporting materials appear in appendixes. 20 figures, 4 tables. (RWR)

3944 (SAND—78-0367C) **Solving ODEs with discrete data in SPEAKEASY.** Shampine, L.F. (Sandia Labs., Albuquerque, NM (USA)). 1978. Contract EY-76-C-04-0789. 16p. (CONF-780586—2). Dep. NTIS, PC A02/MF A01.

From Symposium on recent advances in numerical analysis; Madison, WI, USA (22 May 1978).

SPEAKEASY is a very-high-level language designed to make using computers easy for model building. This paper describes the results of an attempt to provide a capability for solving differential equations (DEs) in the language. The language is representative of situations in which one wants to regard the solution of a DEs as a high-level operation requiring no user intervention. It is necessary to confront the question of solving DEs when it is not possible to evaluate the equation anywhere desired because the DEs are defined only at certain points. The problem to be examined is explained, and an algorithm for its solution is sketched. The development of the algorithm is presented under the headings choice of a basic method, necessary conditions on the step size, varying the order, and error measurement. Three examples are given to clarify the method. (RWR)

3945 (SAND—79-0567C) **IOSYM: a network simulation language for continuous systems.** Polito, J.; Smith, D. (Scientific Simulation, Inc., Albuquerque, NM (USA)). 1979. Contract EY-76-C-04-0789. 28p. (CONF-791043—2). Dep. NTIS, PC A03/MF A01.

From TIMS/ORSA national meeting; Milwaukee, WI, USA (15 Oct 1979).

IOSYM is a network language for simulating systems with many operations, each of which is a continuous process. Time events or crossing conditions may end operations. The network structure permits model construction to be specified by data input. IOSYM is a pre- and post-processor for the GASP IV language. 15 figures, 2 tables.

3946 (SAND—79-0568C) **Recovery of dual variables in Generalized Benders Decomposition.** Polito, J.; Morin, T.L.; McCarl, B.A. (Sandia Labs., Albuquerque, NM (USA); Purdue Univ., Lafayette, IN (USA)). 1979. Contract EY-76-C-04-0789. 17p. (CONF-791043—3). Dep. NTIS, PC A02/MF A01.

From TIMS/ORSA national meeting; Milwaukee, WI, USA (15 Oct 1979).

Direct application of Generalized Benders Decomposition to convex programing problems does not yield the dual variables as part of the solution. Simple computational formulas for recovering the dual variables are presented, and it is shown that the convergence criterion for the decomposition determines the accuracy of the computed dual prices.

3947 (SAND—79-1229C) **Statistical distributions by special functions.** Amos, D.E. (Sandia Labs., Albuquerque, NM (USA)). 1979. Contract EY-76-C-04-0789. 12p. (CONF-790825—5). Dep. NTIS, PC A02/MF A01.

From Annual meeting of the American Statistical Association; Washington, DC, USA (12 Aug 1979).

Computational methods developed for functions of mathematical physics have made the construction of robust computer codes possible for many of the special functions related to statistics. Details of Chebyshev approximation, recursion on three-term recursion relations, and quadrature are considered. 2 tables.

3948 (UCID—18083) **Note on normalization of variables and equations.** Mirin, A.A. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Mar 1979. Contract W-7405-ENG-48. 8p. Dep. NTIS, PC A02/MF A01.

It is pointed out that even in 1979, with 64-bit computer words and exponent ranges of several hundred, care must be exercised to avoid excessive roundoff error when solving coupled systems of partial differential equations. The remedy is proper normalization of variables. An illustration of the procedure is given. (RWR)

3949 (UCID—18163(Pt.2)) **Thermal Complex Information System. 2. Schedules and costs.** Ames, H.S.; Nesbit, E.E.; Posehn, M.R.; Sweeney, S.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1979. Contract W-7405-ENG-48. 59p. Dep. NTIS, PC A04/MF A01.

This document contains a detailed description of the plans to upgrade the Site 300 Thermal/Mechanical test complex (B830, B832, B833, B834). The project started in the fall of 1978, and is expected to be completed in early 1981. Phase I is the purchase of two computers, development of minimal data management capability and data acquisition capability, and installation. The second phase is the acquisition of the three computers (BLD 832), acquisition of B830 hardware, development of calibration units and data capture units for B832, development of full data management capability and installation. Finally, there will be a continuing effort for system evaluation, support, and enhancements. Each of the tasks which comprise TCIS is described. 10 figures, 10 tables. (RWR)

3950 (UCID—18272) **Zoom Transform as a preprocessor for PARET.** Smith, W.D.; Lager, D.L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 18 Sep 1979. Contract W-7405-ENG-48. 25p. Dep. NTIS, PC A02/MF A01.

The PARET algorithm for extracting mode or singularity parameters from a sampled record of transient experimental data has difficulty with data containing modes that are closely spaced in frequency relative to their absolute frequencies. It was felt that preprocessing the data with the so-called Zoom Transform might improve the performance of the PARET algorithm in such cases. This report describes a study carried out to determine the benefits of zooming to mode parameter estimation. The results suggest that zooming can greatly enhance the power of the PARET algorithm for certain types of data and should be implemented as a user option. 7 figures, 4 tables.

3951 (UCID—18295) **QBUS/XBUS interface functional outline.** Hill, J.C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 10 Oct 1979. Contract W-7405-ENG-48. 10p. Dep. NTIS, PC A02/MF A01.

The QBUS/XBUS interface is a quad-size module that plugs into the LSI-11 QBUS and connects to the XBUS (extended bus) by means of 3M connectors at the back of the module. A catalog of the XBUS signals is given, and the two types of address mapping are explained. EAP window and I/O address assignments and the QBUS/XBUS interface block diagram are given. The principle interface functions are listed. 2 figures. (RWR)

3952 (UCRL—82803) **Conditions for two-dimensional physical realizability.** Ekstrom, M.P. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 2 Nov 1979. Contract W-7405-ENG-48. 6p. (CONF-791125—1). Dep. NTIS, PC A02/MF A01.

From 13. Asilomar conference on circuits, systems, and computers; Pacific Grove, CA, USA (5 Nov 1979).

The issues of physical realizability and causality as they arise in two-dimensional (2-D) digital signal processing are considered. A canonical model for a 2-D digital signal processor is adopted, which includes a mapping operator, mapping the 2-D data into a 1-D sequence. By incorporating this operator, the classical concept of 1-D causality can be extended directly to the 2-D case. Both spatial and transform domain conditions are developed for mappings commonly used in applications. 7 figures.

3953 **Simultaneous coordinate relaxation algorithm for large, sparse Matrix Eigenvalue Probelms.** Raffenetti, R.C. (Theoretical Chemistry Group, Chemistry Division, Argonne National Laboratory, Argonne, Illinois 60439). *J. Comput. Phys.;* **32**: No. 3, 403-419(Sep 1979).

A new algorithm for simultaneous coordinate relaxation is described. For the determination of several extreme eigenvalues and eigenvectors of large, sparse matrices the simultaneous aigorithm affords significant advantages in comparison with a coordinate relaxation algorithm applied to determine individual eigenvalues and eigenvectors in turn. Results of application of the algorithm to test matrices are discussed.

3954 **Methods to determine the temperature dependence of the pre-exponential factor of the Arrhenius equation from thermogravimetric data.** Petty, H.R.; Arakawa, E.T.; Baird, J.K. (Oak Ridge National Lab., TN). *J. Therm. Anal.;* **11**: 417-422(1977).

The well-known methods of Coats-Redfern, Freeman-Carroll, and Achar et al. are modified to include the temperature dependence of the pre-exponential factor in the Arrhenius expression for the rate constant. These modifications serve to cast these methods into their most general Arrhenius form. Suggestions are given regarding various numerical methods for extracting the temperature dependence of the preexponential factor from thermogravimetric and derivative thermogravimetric data.

INFORMATION HANDLING

REFER ALSO TO CITATION(S) 3609, 3642

3955 (DOE/TIC—4579-R10(Suppl.6)) **Energy Information Data Base. Serial titles: Supplement 6, February 1978-September 1979.** (Department of Energy, Oak Ridge, TN (USA). Technical Information Center). Sep 1979. 125p. Dep. NTIS, PC A06/MF A01.

This supplement contains changes and additions to TID-4579-R10 (the authority list for serial titles used by the DOE Technical Information Center), and is intended to be used with that publication. Supplements are cumulative from February 1978 until another revision is issued. (RWR)

CIVILIAN DEFENSE

3956 (AD-A—063713) **Emergency sewage procedures duriag crisis relocation, Final report September 1977-November 1978.** Fisher, R.; Dickinson, L.; Meyer, J.; Wagner, T.P. (Scientific Service, Inc.,

Redwood City, CA (USA)). Nov 1978. Contract DCPA01-77-C-0230. 263p. NTIS PC A12/MF A01.

This work was conducted in support of Crisis Relocation Planning(CRP), a comprehensive effort by the Defense Civil Preparedness Agency to prepare contingency plans for the relocation of population from high-risk areas to protect them from the combined blast and radiation effects of nuclear weapons. This program considered one of the most important functions--sewage treatment--in the host areas. With the possible exception of an adequate safe water system, no other municipal function is more critical for public health, especially during emergency situations in host areas where the population may increase as much as five fold. This report is presented in threee parts. Part I, the technical report, provides background material, references, and the rationale behind the development of the manual, which is Part II. Also discussed is the field testing phase including observations and conclusions obtained from this testing. This part of the report may be of interest to Defense Civil Preparedness Agency and state Civil Defense personnel as well as to sewage plant operators.

CORPORATE INDEX

In the Corporate Index, report literature is indexed using the name of the organization or institution responsible for issuing the report. Headings are provided for all report literature and for published literature for which a corporate approach is especially desirable, e.g., symposium and conference proceedings.

Each entry under a corporate heading gives the report title and the volume and abstract numbers. Report numbers, if applicable, are given in parentheses at the end of the entry.

DOE Energy Information Data Base: Corporate Author Entries (TID-4585) is used in the standardization of corporate entries. TID-4585 is available for purchase from the National Technical Information Service (NTIS), U. S. Department of Commerce, Springfield, Virginia 22161.

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The title may be supplemented with additional words, or a phrase, if it appears additional information would be helpful. In cases for which the title contains little or no information related to the subject entry, it may be replaced entirely by the supplementary information. A qualifier is not always required, and in such cases the title will follow the unqualified subject descriptor.

The descriptors selected for use as subject terms are generally the names of specific materials, things, or processes. To the extent possible, a qualifier is selected to describe the properties of, or processses applied to, the subject term.

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CONF-790125-		(1. topical meeting on fusion reactor materials, Miami Beach, FL, USA, 29-31 Jan 1979)
82	5:3930	*See* UCRL-82041

CONF-790150- (Orbis scientiae 1979 conference, Coral Gables, FL, USA, 15-18 Jan 1979)
6 5:3772 *See* DOE/ER-01388-777
CONF-790163- (Orbis Scientiae, Miami, FL, USA, Jan 1979)
3 5:3773 *See* DOE/ER-01388-782
CONF-790214- (1979 winter power meeting, New York, NY, USA, 4-9 Feb 1979)
5:2967 New York, NY; Institute of Electrical and Electronics Engineers, Inc. (1979).
CONF-790242- (Annual conference of the American Institute of Physics, Houston, TX, USA, Feb 1979)
1 5:3765 *See* DOE/ER-01388-775
CONF-790306- (International conference on fast breeder reactor performance, Monterey, CA, USA, 5-8 Mar 1979)
24 5:2989 *See* HEDL-S/A-1552-FP
CONF-790347- (2. international conference on meson-nuclear physics, Houston, TX, USA, 5-9 Mar 1979)
5:3762 54: No. 1, 561-575(15 Jul 1979)
5:3763 54: No. 1, 634-657(15 Jul 1979)
5:3764 54: No. 1, 131-141(15 Jul 1979)
5:3770 54: No. 1, 610-611(15 Jul 1979)
5:3786 54: No. 1, 318-331(15 Jul 1979)
5:3787 54: No. 1, 691-702(15 Jul 1979)
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5:3791 54: No. 1, 440-454(15 Jul 1979)
5:3799 54: No. 1, 272-273(15 Jul 1979)
5:3800 54: No. 1, 357-358(15 Jul 1979)
5:3801 54: No. 1, 658-665(15 Jul 1979)
5:3804 54: No. 1, 178-179(15 Jul 1979)
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5:3815 54: No. 1, 533-534(15 Jul 1979)
5:3839 54: No. 1, 501-514(15 Jul 1979)
5:3840 54: No. 1, 601-602(15 Jul 1979)
5:3841 54: No. 1, 618-619(15 Jul 1979)
CONF-790386- (A colloquy and workshops: regional implications of the engineering manpower requirements of the national energy program, Amherst, MA, USA, 1-2 Mar 1979)
5:3157 *See* COO-4913-1
5:3158 *See* COO-4913-1
5:3167 *See* COO-4913-1
CONF-790395- (Symposium on structure and properties of highly conducting polymers and graphite, San Jose, CA, USA, 29-30 Mar 1979)
1 5:3397 *See* SAND-79-1477C
CONF-790420- (International symposium on ceramics in nuclear waste management, Cincinnati, OH, USA, 30 Apr-2 May 1979)
5:2591 Dep. NTIS, PC A17/MF A01
5:2592 Dep. NTIS, PC A17/MF A01
5:2593 Dep. NTIS, PC A17/MF A01
5:2632 Dep. NTIS, PC A17/MF A01
CONF-7904103- (3. EUCHEM-conference on solid state chemistry and electrochemistry, Endorf, F.R. Germany, 30 Apr-3 May 1979)
2 5:3133 *See* INKA-Conf-79-072-004
4 5:3140 *See* INKA-Conf-79-072-001
CONF-7904110- (2. symposium on the mineral resources potential of the earth, Hannover, F.R. Germany, 18-20 Apr 1979)
2 5:2511 *See* INKA-Conf-79-080-004
3 5:3295 *See* INKA-Conf-79-080-001
CONF-7904116- (Geological Society of America cordilleran section meeting, San Jose, CA, USA, 10 Apr 1979)
1 5:3676 *See* RHO-SA-93
CONF-790541- (International Solar Energy Society meeting, Atlanta, GA, USA, 28 May 1979)
55 5:2793 *See* BNL-26582
CONF-790574- (ASTM symposium Progress in electrochemical techniques, San Francisco, CA, USA, 20-23 May 1979)
2 5:3358 *See* SAND-78-2222C
CONF-790595- (DOE semi-annual review for photovoltaics, Gatlinburg, TN, USA, 16 May 1979)
5:2735 Dep. NTIS, PC A24/MF A01
5:2736 Dep. NTIS, PC A24/MF A01
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CONF-7905110- (Workshop on the future directions of nuclear physics, Boulder, CO, USA, 29 May-2 Jun 1979)
1 5:3809 *See* LBL-9283
CONF-7905116- (Bovine leukosis symposium, College Park, MD, USA, 22-23 May 1979)
2 5:3635 *See* COO-0910-51
CONF-7905117- (Conference on power demand and supply - analysis and strategies, Schliersee, F.R. Germany, 16-17 May 1979)
2 5:2502 *See* INKA-Conf-79-095-002
3 5:3298 *See* INKA-Conf-79-095-005
5 5:3271 *See* INKA-Conf-79-095-007
6 5:3272 *See* INKA-Conf-79-095-008
CONF-790602- (ANS annual meeting, Atlanta, GA, USA, 3-8 Jun 1979)
84(Summ.) 5:3003 *See* HEDL-SA-1762-S
CONF-790615- (3. US national congress on pressure vessels and piping, San Francisco, CA, USA, 25-29 Jun 1979)
14 5:3006 Dep. NTIS, PC A04/MF A01
CONF-790634- (72. annual Air Pollution Control Association meeting, Cincinnati, OH, USA, 24-28 Jun 1979)
5 5:3277 Institute of Gas Technology, 3424 S. State St., Chicago, IL 60616
6 5:3278 Chicago, IL; Institute of Gas Technology (1979).
CONF-790635- (10. transducer workshop, Colorado Springs, CO, USA, 12-14 Jun 1979)
4 5:3559 *See* UCRL-81669
CONF-790641- (Rare earth research conference, Fargo, ND, USA, 25-28 Jun 1979)
11 5:3399 Dep. NTIS, PC A02/MF A01
CONF-790648- (Neutrino 1979 conference, Bergen, Norway, 18-22 Jun 1979)
7 5:3754 *See* BNL-26498
CONF-790653- (Superconductivity in d- and f-band metals, San Diego, CA, USA, 21-23 Jun 1979)
15 5:3344 Dep. NTIS, PC A02/MF A01
CONF-790690- (4. international conference on laser spectroscopy, Rottach-Egern, Tegernsee, F.R. Germany, 11-15 Jun 1979)
4 5:3456 *See* LBL-9782
CONF-7906103- (International conference on martensitic transformation, Boston, MA, USA, 24-29 Jun 1979)
1(Rev.) 5:3326 *See* LBL-9346(Rev.)
CONF-7906128- (46. Nobel symposium on many-body theory of atomic systems, Aspenasgarden, Lerum, Sweden, 11-16 Jun 1979)
1 5:3852 *See* BNL-26658

CONF-7906137- (Lecture meeting on optimized energy economy in industry, Essen, F.R. Germany, 5 Jun 1979)
002 5:3291 *See* INKA-Conf-79-171-001
CONF-790708- (XIV conference internationale sur les phenomenes d'ionisation dans les gaz, Grenoble, France, 9-13 Jul 1979)
5(Rev.1) 5:3931 *See* UCRL-82835(Rev.1)
CONF-790738- (Joint INTERMAG-MMM conference, New York, NY, USA, 17-20 Jul 1979)
4 5:3383 Dep. NTIS, PC A02/MF A01
CONF-790743- (Symposium on heavy ion physics from 10-200 MeV/A, Upton, NY, USA, 16-20 Jul 1979)
7 5:3808 Dep. NTIS, PC A02/MF A01
CONF-790758- (DOE regional solar update conference, Dearborn, MI, USA, 11-13 Jul 1979)
1 5:2842 *See* SOLAR/0022-79/39
CONF-790759- (1. international workshop on reactive metal-air batteries, Bonn, F.R. Germany, 9-11 Jul 1979)
2(Rev.2) 5:3134 *See* UCRL-82497(Rev.2)
CONF-790765- (10. international conference on solid state nuclear track detectors, Lyons, France, 2-7 Jul 1979)
1 5:3549 *See* HEDL-SA-1804
2 5:3550 *See* HEDL-SA-1806
CONF-790773- (Gordon research conference, Andover, NH, USA, 9-13 Jul 1979)
1 5:3332 *See* DP-MS-79-57
CONF-790802- (International conference on structural mechanics in reactor technology, Berlin, F.R. Germany, 13-17 Aug 1979)
76 5:3078 *See* UCRL-81567
77 5:3929 *See* UCRL-81673
CONF-790803- (14. intersociety energy conversion conference, Boston, MA, USA, 5-10 Aug 1979)
45 5:3018 Dep. NTIS, PC A02/MF A01
CONF-790804- (7. conference on electronic computation, St Louis, MO, USA, 6-8 Aug 1979)
2 5:2574 *See* HEDL-SA-1738-FP
CONF-790808- (18. ASME national heat transfer conference, San Diego, CA, USA, Aug 1979)
21 5:2915 *See* LBL-9720
CONF-790815- (Cryogenic engineering conference, Madison, WI, USA, 21-24 Aug 1979)
32 5:3682 *See* LBL-9699
CONF-790816- (International meeting on fast reactor safety technology, Seattle, WA, USA, 19-23 Aug 1979)
54 5:3073 *See* SAND-79-1733C
59 5:3038 Dep. NTIS, PC A02/MF A01
63 5:3022 *See* HEDL-SA-1744-FP
64 5:2990 *See* HEDL-SA-1751
65 5:3050 *See* HEDL-SA-1752-FP
70 5:3049 *See* HEDL-SA-1736-FP
73 5:3048 *See* HEDL-SA-1731-FP
CONF-790825- (Annual meeting of the American Statistical Association, Washington, DC, USA, 12-16 Aug 1979)
5 5:3947 *See* SAND-79-1229C
CONF-790836- (16. international cosmic rays conference, Kyoto, Japan, 6-18 Aug 1979)
6 5:3745 *See* FERMILAB-CONF-79/32-EXP
CONF-790847- (International conference on high energy physics and nuclear structure, Vancouver, Canada, 13-17 Aug 1979)
13 5:3747 *See* ANL-HEP-CP-79-24
CONF-790855- (Symposium on instrumentation and control for fossil energy processes, Denver, CO, USA, 20-22 Aug 1979)
4 5:3600 *See* SAND-79-8056
CONF-790862- (3. international conference on phonon scattering in condensed matter, Providence, RI, USA, 28-31 Aug 1979)
2 5:3384 Dep. NTIS, PC A02/MF A01
CONF-790873- (Post-SMIRT seminar, Brussels, Belgium, 23 Aug 1979)
1 5:3039 Dep. NTIS, PC A02/MF A01
CONF-790875- (Conference on diffraction profile analysis and open meeting of the commission on neutron diffraction, Cracow, Poland, 14-15 Aug 1979)
1 5:3552 Dep. NTIS, PC A02/MF A01
CONF-790884- (Post-SMiRT5 second international seminar on mathematical/mechanical modeling of reactor fuel elements, Berlin, F.R. Germany, 20-21 Aug 1979)
1 5:3014 Dep. NTIS, PC A02/MF A01
CONF-790886- (Second law of thermodynamics workshop, Washington, DC, USA, 14-16 Aug 1979)
1 5:2405 Chicago, IL; Institute of Gas Technology (1979).
CONF-790888- (US-Japan seminar on two-phase flow dynamics, Tokyo, Japan, 1-3 Aug 1979)
1 5:3005 *See* BNL-NUREG-26789
CONF-790901- (15. international congress on refrigeration, Venice, Italy, 23-29 Sep 1979)
1 5:2970 *See* DOE/NASA-0207-79/3
2 5:3511 *See* DOE/NASA/0207-79/1
CONF-790904- (Systems engineering for power: emergency operating state control conference, Davos, Switzerland, 30 Sep-5 Oct 1979)
P1 5:2946 Dep. NTIS, PC A25/MF A01
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CONF-790910- (Symposium on calculation of phase diagrams and thermochemistry, Milwaukee, WI, USA, 17-19 Sep 1979)
3 5:3331 *See* DP-MS-79-18
CONF-790917- (American Chemical Society national meeting, Washington, DC, USA, 10-14 Sep 1979)
11 5:2786 *See* BNL-26721
CONF-790922- (Workshop on nude mice, Bozeman, MT, USA, 6-9 Sep 1979)
2 5:3637 Dep. NTIS, PC A02/MF A01
CONF-790925- (9. international conference on the properties of steam, Munich, F.R. Germany, 10-14 Sep 1979)
1 5:3425 *See* LBL-9571
CONF-790927- (Linear accelerator conference, Montauk, NY, USA, 10-14 Sep 1979)
24 5:3543 *See* SLAC-PUB-2380
29 5:3536 *See* BNL-26780
30 5:3540 *See* LBL-9619
CONF-790942- (Hydrogen in air transportation conference, Stuttgart, F.R. Germany, 10-14 Sep 1979)
2 5:2706 The Publisher, 3424 S. State St., Chicago, IL 60616
CONF-790950- (International seminar on ion-atom collisions (ISIAC VI), Tokai-mura, Japan, 6-7 Sep 1979)
1 5:3727 Dep. NTIS, PC A02/MF A01
CONF-790959- (Conference on theory and applications of moment methods in many fermion systems, Iowa City, IA, USA, 10-13 Sep 1979)
2 5:3834 *See* UCRL-83462
CONF-790966- (International conference on acoustic emission, Anaheim, CA, USA, 10-13 Sep 1979)
1 5:3007 Dep. NTIS, PC A03/MF A01
CONF-790968- (6. international conference on atomic masses, East Lansing, MI, USA, 18-21 Sep 1979)
3 5:3810 Dep. NTIS, PC A02/MF A01
CONF-790974- (Specialists meeting on accuracies in correlation between property change and exposure data from reactor pressure vessel steel irradiations, Julich, F.R. Germany, 24-27 Sep 1979)
1 5:3002 Dep. NTIS, PC A02/MF A01
CONF-790976- (International symposium on future directions in studies of nuclei far from stability, Nashville, TN, USA, 10-13 Sep 1979)
1 5:3785 Dep. NTIS, PC A02/MF A01
2 5:3816 Dep. NTIS, PC A02/MF A01
3 5:3818 Dep. NTIS, PC A02/MF A01
4 5:3812 *See* UCRL-83319
5 5:3020 *See* DOE/ER/10493-1
CONF-790979- (Annual information meeting, Richland, WA, USA, 25-27 Sep 1979)
2 5:3361 Dep. NTIS, PC A02/MF A01

CONF-790985- (Seminar on design and construction of LNG and LPG storage, Bethioua, Algeria, Sep 1979)
1 5:2524 The Publisher, 3424 South State St., Chicago, IL 60616
CONF-790986- (Royal Society conference on neutron scattering in biology, chemistry, and physics, London, UK, 26-27 Sep 1979)
1 5:3850 *See* BNL-26801
CONF-790988- (6. internet international Management System Association meeting, Garmisch-Partenkirchen, F.R. Germany, 24-28 Sep 1979)
1 5:3168 *See* HEDL-SA-1826-FP
CONF-791003- (3. Eastern gas shales symposium, Morgantown, WV, USA, 1-3 Oct 1979)
5:2513 *See* METC/SP-79/6
5:2516 *See* METC/SP-79/6
5:2522 *See* METC/SP-79/6
CONF-791009- (International conference on energy use management, Los Angeles, CA, USA, 22-26 Oct 1979)
7 5:3204 *See* BNL-26397
CONF-791016- (1979 DOE statistical symposium, Gatlinburg, TN, USA, 24-26 Oct 1979)
2 5:3939 Dep. NTIS, PC A02/MF A01
3 5:2642 *See* SAND-79-1197C
CONF-791017- (7. international conference on chemical vapor deposition, Los Angeles, CA, USA, 14-19 Oct 1979)
10 5:3139 *See* SAND-79-0869C
CONF-791018- (Symposium on advances in particulate sampling and measurement, Daytona Beach, FL, USA, 7-10 Oct 1979)
1 5:3595 *See* LA-UR-79-2421
CONF-791022- (4. national passive solar energy conference, Kansas City, KS, USA, 3-5 Oct 1979)
10 5:2841 *See* SERI/TP-69-412
CONF-791036- (5. conference of powder metallurgy, Poznan, Poland, 3-5 Oct 1979)
1 5:3386 *See* LA-UR-79-1112
CONF-791037- (IEEE nuclear science symposium, San Francisco, CA, USA, 17-19 Oct 1979)
3 5:3080 *See* UCRL-83489
CONF-791043- (TIMS/ORSA national meeting, Milwaukee, WI, USA, 15-17 Oct 1979)
2 5:3945 *See* SAND-79-0567C
3 5:3946 *See* SAND-79-0568C
4 5:3190 *See* UCRL-83469
CONF-791045- (American Ceramic Society conference, New Orleans, LA, USA, 14-17 Oct 1979)
2 5:3381 *See* HEDL-SA-1813
3 5:3382 *See* HEDL-SA-1858
CONF-791046- (14. Princeton/AIAA/DLGR international electric propulsion conference, Princeton, NJ, USA, 30 Oct-1 Nov 1979)
1 5:2996 *See* LA-UR-79-2516
CONF-791047- (11. annual electro optics/laser conference and exposition, Anaheim, CA, USA, 23-25 Oct 1979)
2 5:3927 *See* LA-UR-79-2757
CONF-791049- (23. conference on analytical chemistry in energy technology, Gatlinburg, TN, USA, 9-11 Oct 1979)
7 5:3416 Dep. NTIS, PC A02/MF A01
13 5:3415 Dep. NTIS, PC A02/MF A01
CONF-791051- (3. ASTM-EURATOM symposium on reactor dosimetry, Ispra, Italy, 1-5 Oct 1979)
1 5:3019 Dep. NTIS, PC A02/MF A01
3 5:3826 *See* BNL-NCS-26760
CONF-791058- (International conference on nuclear cross sections for technology, Knoxville, TN, USA, 22-26 Oct 1979)
1 5:3788 *See* UCRL-83005
2 5:3915 *See* GA-A-15594
3 5:3806 *See* UCRL-82998
4 5:3829 *See* BNL-26805
6 5:3871 *See* LA-UR-79-2867
11 5:3830 *See* LA-UR-79-2890
CONF-791060- (IEEE symposium on nuclear power systems, San Jose, CA, USA, 19 Oct 1979)
1 5:3079 *See* UCRL-82227
CONF-791061- (American Ceramic Society fall meeting, Bedford, PA, USA, 10-12 Oct 1979)
1 5:2607 *See* DP-MS-79-42
CONF-791063- (Conference on thermodynamics of aqueous systems with industrial applications, Washington, DC, USA, 22-24 Oct 1979)
1 5:3426 *See* LBL-9788
CONF-791067- (32. Pacific Coast regional meeting of the American Ceramic Society, Seattle, WA, USA, 24-26 Oct 1979)
1 5:3391 *See* GA-A-15508
CONF-791068- (General Electric materials characterization symposium, Schenectady, NY, USA, 24-26 Oct 1979)
1 5:2698 *See* GEPP-OP-463
CONF-791073- (US/Japan joint seminar on defects and diffusion in solids, Honolulu, HI, USA, 10-12 Oct 1979)
1 5:3379 *See* LBL-9802
CONF-791074- (US/USSR exchange meeting on fast reactor safety, Moscow, USSR, 8 Oct 1979)
1 5:3023 *See* HEDL-SA-1945
CONF-791075- (International symposium on superconductive energy storage, Osaka, Japan, 8-10 Oct 1979)
2 5:2968 *See* LA-UR-79-2774
CONF-791102- (8. symposium on engineering problems of fusion research, San Francisco, CA, USA, 13-16 Nov 1979)
2 5:3918 *See* UCRL-82913
3 5:3487 *See* UCRL-83307
5 5:3935 *See* UCRL-82914
6 5:3868 *See* UCRL-83208
8 5:3919 *See* LBL-9997
CONF-791103- (American Nuclear Society meeting, San Francisco, CA, USA, 12-16 Nov 1979)
37 5:3032 Dep. NTIS, PC A02/MF A01
38 5:3033 Dep. NTIS, PC A02/MF A01
40 5:2586 *See* AGNS-35900-CONF-41
CONF-791109- (5. workshop on laser interaction, Rochester, NY, USA, 5-9 Nov 1979)
1 5:3932 *See* UCRL-83342
CONF-791112- (Symposium on the scientific basis for nuclear waste management, Boston, MA, USA, 26-29 Nov 1979)
6 5:2640 *See* SAND-79-0895C
11 5:2634 *See* DP-MS-79-37
12 5:2608 *See* DP-MS-79-70
14 5:2641 *See* SAND-79-1013C
15 5:2673 *See* SAND-79-1016C
16 5:2672 *See* SAND-79-0900C
17 5:2602 Dep. NTIS, PC A02/MF A01
CONF-791118- (7. water reactor safety research information meeting, Gaithersburg, MD, USA, 5-9 Nov 1979)
1 5:3074 *See* SAND-79-1963C
CONF-791125- (13. Asilomar conference on circuits, systems, and computers, Pacific Grove, CA, USA, 5-6 Nov 1979)
1 5:3952 *See* UCRL-82803
CONF-791126- (26. annual western regional conference of ASQC, San Diego, CA, USA, 1-3 Nov 1979)
1 5:2579 *See* GA-A-15662
CONF-791203- (Health Physics Society meeting, Honolulu, HI, USA, 10-14 Dec 1979)
3 5:2680 *See* HEDL-SA-1816
CONF-791205- (ASME winter annual meeting, New York, NY, USA, 2-7 Dec 1979)
3 5:2983 Dep. NTIS, PC A02/MF A01
8 5:3340 *See* UCRL-83148
15 5:2794 *See* BNL-26772
CONF-791209- (Institute of Gas Technology symposium, Atlanta, GA, USA, 3-6 Dec 1979)
1 5:2534 *See* UCRL-83568
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